Banbury, Woodstock, Bicester, and Buckingham. GREEN.

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45.

MEMOIRS

OF THE

GEOLOGICAL SURVEY

OF

GREAT BRITAIN,

AND OF THE

MUSEUM OF PRACTICAL GEOLOGY.

THE GEOLOGY OF THE COUNTRY ROUND

BANBURY, WOODSTOCK, BICESTER, AND BUCKINGHAM.

(Sheet 45 of the Map of the Geological Survey of Great Britain.)

BY

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LISTS OF FOSSILS BY R. ETHERIDGE, F.R.S.E., F.G.S.

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THE GEOLOGY

OF

THE COUNTRY ROUND BANBURY, WOODSTOCK, BICESTER, AND BUCKINGHAM.

(Sheet 45 of the Map of the Geological Survey of Great Britain.)

CHAPTER I.

Introductory.

The description of the Geology of the country lying within Sheet 45 of the Map of the Geological Survey of Great Britain, which is the object of the present Memoir, has been drawn up from the following sources. For the S.W. quarter I have used the map and descriptive memoir of Mr. E. Hull. The N.W. and S.E. quarters and the north-western half of the N.E. quarter were surveyed by Messrs. E. Hull, H. Bauerman, W. Whitaker, and T. R. Polwhele, and here I have had the help of their guidance and notes,* to which I have been able to add a few observations of my own. Much very valuable information about the neighbourhood of Oxford was kindly placed in my hands by Prof. Phillips. For the mapping and description of the remainder, and for the general arrangement of the Memoir, I am myself answerable.

The fossils lists have been drawn up by Mr. Etheridge, from a paper by Mr. Whiteaves, read before the British Association in 1860; from Professor Phillips' article on the "Geology of the Neighbourhood of "Oxford," in the Oxford Essays for 1855; from Dr. Fitton's paper on the Strata below the Chalk (Trans. Geol. Soc. 2nd series, vol. iv.); and from collections made by the officers of the Survey.

The map contains about 600 square miles, and takes in parts of the counties of Gloucestershire, Northamptonshire, Oxfordshire, and Buckinghamshire. The chief towns are Banbury, Chipping Norton, and Deddington in the N.W. quarter; Buckingham and Brackley in the N.E.; Woodstock and Witney in the S.W.; and Bicester in the S.E.

* The account of the Portland, Purbeck, and Cretaceous beds is almost wholly from the pen of Mr. Whitaker,

The Geological Formations that are met with are;

Post-Pliocene.	Low-level Gravels.
	Clays and Gravels of the Boulder period
Cretaceous.	Upper. Gault.
	Lower. Lower Greensand.
Upper Oolite.	Purbeck Beds.
	Portland Stone.
	Portland Sand.
	Kimeridge Clay.
Middle Oolite.	Coral Rag.
	Lower Calcareous Grit.
	Oxford Clay.
Lower Oolite.	Cornbrash.
	Forest Marble.
	Great or Bath Oolite.
	Inferior Oolite.
Lias.	Upper Lias Clay.
	Marlstone.
	Lower Lias Clay.

Physical Geography of the District.

The physical features are such as everywhere mark the Oolitic districts of central England.

The clays and limestones of which the Oolite series is made up are brought in turn to the surface by a gentle rise of the beds to the north-west. The softer strata, yielding more easily to denudation, form valleys or gently undulating plains; while the harder limestones have given rise to table lands, rising slightly to the north-west, and ending with a sharp cliff-like edge at their junction with the clays below.

These features can be fully seen, however, only where the country is free from Drift. Over a great part of the eastern half of the map a thick covering of clay and gravel hides them from sight, spreading with a sameness of outline over the whole of the country.*

A small patch at the north-east corner of the map, rather tame in look, is occupied by the Lower Lias Clay.

Between the escarpment of the marlstone which bounds this tract on the east and the escarpment of the Great Oolite lies a plateau of marlstone, channelled by the valleys of the Cherwell and its branches, which cut down to the Lower Lias, and studded over with hills of Upper Lias Clay, often capped by Great Oolite beds. Many outlying patches of the two last-named formations, which have been let down into the marlstone by faults, and so saved from denudation, are found over the plateau.

From the plateau just described the Great Oolite rises on the east with a bold escarpment, running from Chipping Norton through Dunstew and Aynho to Farthinghoe. "The rock forms a tabulated "surface, intersected by narrow channel-like valleys, and sloping

* Here too, from the absence of these guiding features, it becomes difficult, at times impossible, to fix exactly the boundaries of the several formations. They have been drawn as closely as the state of things would allow, and I shall endeavour to explain below the grounds on which they rest and how far they may be relied upon.

" gradually to the south at an angle of about 1°, nearly corresponding " with the dip of the beds."* We have here in fact a repetition of the Marlstone plateau, and one like it dotted over in Whychwood Forest with outliers, formed in this case of Forest Marble and capped by Cornbrash and Oxford Clay. Towards the north-east a thick covering of Drift lies upon the Great Oolite, and gives to the country a more undulating surface.

The Cornbrash, where broad spreads of it free from Drift occur, forms plains so flat as almost to bring to mind the fens of Lincolnshire. The country round Bicester is a case in point.

The Oxford Clay, the formation next above, " generally commences " in the form of a low ridge of wet ground, rising above the flat " surface of the Cornbrash. Of these ridges examples occur at " Leafield, Ramsden Heath, Witney, Round Castle near Bladon, " Tackley Heath, Kirklington, Bletchingdon,"† and between Stratton Audley and Fringford.

The greater part of the remainder of the map is occupied by this formation and the Kimeridge Clay, and the country is feebly undulating and heavy in look. It is broken by a row of inliers of Cornbrash, brought up along an anticlinal line ranging from Islip to Marsh Gibbon, which however form no very marked objects in the landscape. To the south-east of these hills several outliers of Portland Oolite, capped by Lower Greensand, specially those of Quainton, Brill, and Muswell Hills, and the Coralline Oolite headland of Wytham Hill, stand out in pleasing contrast to the dreary sameness of the clay country.

The outcrop of the Coral Rag for the most part makes but little show ; to the south, however, " it forms a tabulated area on which are " built the villages of Headington, Elsfield, Beckley, and Stanton St. " John."‡

The following are the approximate heights in feet of some of the chief points above the level of the sea :—Wytham Hill, 583 ; R. Isis at Oxford, 190 ; Junction of the Evenlode and Isis, 237 ; Woodstock Church, 323 ; hill half a mile north of Chipping Norton, 728 ; Epwell Hill, 836 ; Banbury Canal, 315 ; high ground of Whittlewood Forest, 360 ; Canal at Buckingham, 250 ; Quainton Hill, 754 ; Muswell Hill, 744.

The drainage of the country is carried off by three rivers, the Severn, the Thames, and the Ouse.

A small triangle at the north-west corner of the map, coinciding very nearly with the area occupied by the Lower Lias, is drained by the river Stour, which finds its way, through the Avon, into the Severn.

This tract is bounded by a line which enters the map by the high ground of Shenlow and Epwell Hills (the latter, 836 feet above the sea, being the highest point in the district), runs west of Epwell to Tadmarton Camp, and then turning to the south-west follows the ridge of Rollerich Hill.

It will be seen that this line of watershed runs very nearly along the Marlstone escarpment.

To the east of the line just marked out lies a part of the valley of the Thames, drained by four tributaries of that river, the Windrush, the Evenlode, the Cherwell, and the Thame.

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* Geology of the Country round Woodstock (Mems. of Geol. Survey), p. 15.
† Geology of the Country round Woodstock, p. 26.
‡ Geology of Parts of Oxon and Berks (Memoirs of Geol. Survey), p. 7.

The Windrush runs by Asthall and Witney, and falls into the Isis at Newbridge ; it drains the south-west corner of the map.

The part of the Evenlode within this sheet has a south-easterly course, and enters the Isis a few miles above Oxford. "The Evenlode "has its sources in the Vale of Moreton, and it is remarkable that its "valley has cut through the barrier formed by the Great Oolite, while "apparently a little more denudation would have drained its waters "into the vale of the Avon, which flows through a more northerly "part of the same Liassic valley."*

The Cherwell runs with a southerly course by Banbury into the Isis at Oxford.

Lastly, the brooks in the south-east part of the sheet fall into the Thame, which joins the Thames at Dorchester in Oxfordshire.

The valley of the Great Ouse is divided from that of the Thames by a watershed which enters the map near Thenford Camp and runs by Farthingho, Cottesford, Heath, and Fritwell nearly to Somerton, and then turns east by south through Ardley and Fringford to Quainton Hill. From Somerton northwards the watershed is formed by the escarpment of the Great Oolite, but for the rest of its course it nowhere follows any marked physical feature.

The Ouse rises near Brackley and runs with an easterly course to Buckingham. The larger number of its feeders in this country fall directly into it; a subordinate watershed, however, reaching from Marston Hill Farm to the high ground of Whittlewood Forest turns the brooks to the north of it into the Tove, which joins the Ouse near Stony Stratford.

With the exception of a few manufactories in some of the towns, the country is wholly agricultural. The clay lands are mostly laid out for grazing; their soil is wet and cold, but is much improved by deep draining. Good corn land is found over much of the limestone country. The following table, by Professor Buckman,† gives the chemical composition, yield, and rent of the different oolitic "brashes" in the country round Cirencester, and will be some guide on these points for the present country.

	Inferior Oolite.	Great Oolite.	Cornbrash.
Carbonate of lime	89·20	95·346	89·195
Magnesia	0·34	0·793	0·771
Sulphate of lime	0·09	0·204	0·241
Alumina	4·14	1·422	2·978
Phosphoric acid	0.06	0·124	0·177
Soluble silica	2·75	1·016	1·231
Insoluble siliceous matter	3·27	0·533	4·827
Alkaline salts, undetermined	—	—	—
Rent per acre	7*s.* to 20*s.*	14*s.* to 25*s.*	20*s.* to 40*s.*
Yield per acre in bushels :—			
Wheat	15 to 20	20 to 25	25 to 30
Barley	25 to 30	30 to 35	40 to 45
Oats	25 to 30	35 to 40	45 to 50

The Drift land is ploughed or grazed according as gravel or clay prevail in it.

* Geology of the Country round Woodstock (Mems. of Geol. Survey), p. 1.
† Quarterly Journal of Geol. Soc. vol. xiv. p. 120.

CHAPTER II.

LIAS.

Lower Lias.—The upper part only of this division is seen in the district; it consists of dark blue clays and shales. As before mentioned the Lower Lias covers a small tract at the north-west corner of the map, and occurs along parts of the valleys of the Evenlode and the Cherwell and their tributary brooks. Sections are seldom to be met with; the following, laid open in a brick pit at Banbury, near the Railway Station, is worth notice.

	ft.	in.
1. Finely laminated blue clay - - - -	13	0
2. Hard, coarse, shelly limestone, crowded with fossils -	1	0
3. Strong blue shale, with many fossil shells.		

No. 2, which is known as Banbury Marble, takes a fair polish and is worked into mantelpieces and ornaments; it yielded the following fossils:

Fossils from the Upper Part of the Lower Lias, near the Railway Station, Banbury.

Lamellibranchiata.

Pecten sublævis, Phil.
P. textorius, Schloth.
P. æquivalvis, Sow.
Gryphæa Maccullochii, Sow.
G. gigantæa, Sow.
Avicula novemcostæ, Brown.
Lima punctata, Sow.
Pinna.
Hippopodium ponderosum, Sow.
Cardinia hybrida, Stuch.
C. cuneata, Stuch.
Leda complanata, Phill.
Gresslya unionides, Goldf.
Pholadomya ambigua, Sow.

Cephalopoda.

Ammonites Henleyi, Sow.

"During the excavations for the Oxford and Worcester Railway several sections were opened in the Lias, the principal of which are at Shipton Station beyond the border of the sheet, and at Ascott within its edge. At the latter place the skeleton of an Ichthyosaurus was found under Oolitic gravel containing the bones and tusks of a fossil elephant. These cuttings are now concealed by grass, and except in a brick pit on the north side of the valley opposite Ascott, there are no sections. The presence of the Lias at the base of the Marlstone is, however, easily ascertained by the clayey nature of the ground, the outburst of springs, and indications by the roadside sufficient to enable the surveyor to trace his boundary lines, but not enough to afford a knowledge of the strata or their organic contents. In the section at Ascott we have an example of the highest beds. They consist of bluish shales, weathering grey and brown, with small nodules of earthy limestone and iron-concretions."*

Fossils from the Upper Part of the Lower Lias at Banbury Railway Station.

MOLLUSCA.

Lamellibranchiata.

Gryphæa Maccullochii, Sow.
G. cymbium, Lam.
G. gigantæa, Sow.
Pecten sublævis, Phil.
P. æquivalvis, Sow.
P. textorius, Schloth.
Lima punctata, Sow.
Pinna.
Ostrea.
Modiola cuneata, Sow.
Hippopodium ponderosum, Sow.
Cardinia hybrida, Stuch.
C. cuneata, Stuch.
Leda complanata, Phil.
Gresslya unionides, Goldf.
Unicardium.
Pholadomya ambigua, Sow.

Cephalopoda.

Ammonites Henleyi, Sow.

* Geology of the Country round Woodstock (Memoirs of Geol. Survey), p. 9.

Fossils from the Upper Part of the Lower Lias of Warkworth.

MOLLUSCA.

Lamellibranchiata.

Pecten æquivalvis, Sow.
Avicula novemcostæ, Brown.
Modiola cuneata, Sow.
Goniomya rhombifera, Goldf.
Goniomya.
Hippopodium ponderosum, Sow.
Ceromya.
Arca truncata, Buckm.
Pholadomya ambigua, Sow.

Gasteropoda.

Pleurotomaria rotelliformis.

Marlstone or *Middle Lias*.—This part of the Lias, in which sand rather than clay prevails, may be subdivided into two parts. The upper, or Rock Bed, is a calcareous sandstone, often highly charged with Iron, blue or green internally, but weathering dark brown after exposure to the air, in consequence of the change of the protoxide of iron which it contains into peroxide. The lower and larger part consists of sands, clays, and sandstones. Fossils are met with in places in great numbers, chiefly in the Rock Bed, which is at times almost made up of *Rhynchonellæ* and *Terebratulæ;* fossil wood is also common.

The Marlstone forms a broad platean, with outliers of Upper Lias standing on it, to the west and south of Banbury, and a terrace of it runs along the east side of the valley of the Cherwell down to Rousham. It also crops out in narrow belts on each side of the valley of the Evenlode, and inliers of it peep up in the hollows about Heythrop and Enstone.

Over the plateau on the north-west of the district the Rock Bed is largely worked for building and road making, but it has as yet nowhere been found rich enough to be worth getting as an Iron Ore.* Quarries are from time to time opened, and filled up again when the local demand for the stone has ceased; it would therefore be useless to mention any in particular, but the observer will not find it hard to light upon plenty of good sections. The sands and sandstones below the Rock Bed may be well seen in a cutting on the road from Banbury to Middleton Cheney, just before reaching the village. At the base of the Marlstone hereabouts lies a bed of very hard, fine-grained, dark blue limestone, giving out a bituminous smell when struck. It makes good road metal, and has been largely worked about Overthorpe. It may also be seen in a brick pit, north-west of King's Sutton, where Twyford Lane crosses the canal; the section here shows

Marlstone clay.
Bottom blue rock, about 2 feet. } - Marlstone.
Lower Lias clay, with large nodules of clay ironstone.

The junction of this formation with the Great Oolite is shewn in a quarry near Hotley Hill Farm, N.W. of Hook Norton. The section below is from Mr. Bauerman's Note Book.

Bluish crystalline oolite, rather sandy.
Upper lias clay.
Limestone
Ironstone } Marlstone rock bed, 14 inches.
Sandy micaceous clays.

---

* My colleague Mr. Howell, who has been in the country since the above was written, tells me that in the neighbourhood of Swaleliffe this bed is found to be a good ironstone of from six to nine feet in thickness, and that it may possibly be found worth working, when the country to the west of Banbury is more opened up by railway.

Fossils from the Middle Lias of the Banbury District, and which occur in almost every Section and Quarry where these Beds are opened.

MOLLUSCA.

Brachiopoda.

Rhynchonella tetrahedra, Sow.
R. rimosa, Buch.
Terebratula resupinata, Sow.
T. subpunctata, Sow.
T. punctata, Sow.
T. Edwardsii, Dav.

Lamellibranchiata.

Avicula novemcostæ, Brown.
Pecten æquivalvis, Sow.

Cephalopoda.

Belemnites Bruguieri, D'Orb.
B. elongatus, Mill.

"In the road sections at Chadlington and Dean Marlstone with other associated Liassic beds may frequently be seen. At West End a bed of blue clay occurs immediately under the Rock Bed, and at Dean *Ammonites* may be found in the road cuttings, *A. annulatus* being very plentiful. In the lane leading from Fawler to Tapples Wood, on the west side of the railway, the following section is exposed to view :

1. Great Oolite. White shelly oolite (not well seen).
2. Inferior Oolite. Coarse rubbly oolite. - - fee
3. Upper Lias. Grey shales and clays. - - - 5 ,
4. Marlstone Rock Bed. Iron Ore. - - - 8
5. Marlstone Sands. Fine sand, with beds of concretionary iron ore in the topmost bed. - - - 15 ,,

The Marlstone Rock Bed may also be seen in the railway between Fawler and Charlbury, and is nearly 10 feet thick. At Enstone the valley of the Glyme has been excavated into Marlstone, and in the roads which cross it there are several sections, especially at Woodford. In the road on the right bank of the Cherwell, opposite Lower Heyford, there are several good sections, and here *Rhynchonella tetrahedra* occurs plentifully. In all these places the character of the sub-formation is similar, the Rock Bed being essentially an iron ore, and resting on beds of sand with bands of siliceous limestone. The thickness of the sub-formation is about 20 feet.

West of Charlbury the Rock Bed is not so ferruginous as on the opposite side of the town, nor is its thickness so great ; it is cut through by the railway in several places, and a section may be observed along the road which crosses the valley east of Shorthampton."*

In the neighbourhood of Blenheim the Rock Bed becomes a valuable iron ore ; full particulars will be found in Mr. Hull's Memoir on the Geology of the Country round Woodstock, p. 10.

Upper Lias Clay.—This division of the Lias is made up of dull-blue shales and clays, with here and there beds of earthy limestone. Selenite is not uncommon in the clay.

Many outliers of Upper Lias lie scattered over the Marlstone plateau, and in the valleys which run up into the Great Oolite country it is found either cropping out in narrow strips along the sides, or forming the bottom of the hollows. Thus a belt of it skirts the upper part of the valley of the Evenlode, and the valley of the Ouse from Brackley northwards is wholly in this formation.

At the base lies a thin but well marked series of whitish marly clays, with bands of white or cream-coloured earthy limestones. These beds are highly fossiliferous, the species found in them being all distinct from those which are met with in the Marlstone : they may be seen and their fossils compared with those of the Marlstone Rock Bed

* Geology of the Country round Woodstock (Mem. of the Geol. Survey), p. 9, 10.

in many quarries round Banbury. A few of these shall now be pointed out. We may first give a list of the ammonites characteristic of these beds; they are

Ammonites serpentinus, Rein.
A. bifrons, Sow.
A. normanianus, D'Orb.
A. annulatus, Sow.

In a quarry at Chalcomb, on the road leading to Thenford Camp, four or five feet of these beds were seen resting on the Marlstone; fossils were plentiful in both, and a careful search by Mr. T. McK. Hughes failed to bring to light any species common to the two, the Marlstone being crowded with *Rhynchonella tetrahedra, R. resupinata,* and *Terebratulæ,* while the Lias clays yielded *Ammonites communis, A. annulatus, A. serpentinus,* and *A. bifrons.*

About a quarter of a mile from Middleton Cheney, on the road to Marston St. Lawrence, a small quarry gave the section below:

	ft.	in.	
Soil.	0	11	
Clay, with ammonites.	1	6	Basement beds of the Upper Lias.
White earthy limestone.	0	5	
Clay.	2	8	
White earthy limestone.	0	7	
Clay.	4	0	
Marlstone rock bed.			

The clay and limestones contained the usual *Ammonites serpentinus, A. bifrons,* and *A. falcifer,* in plenty.

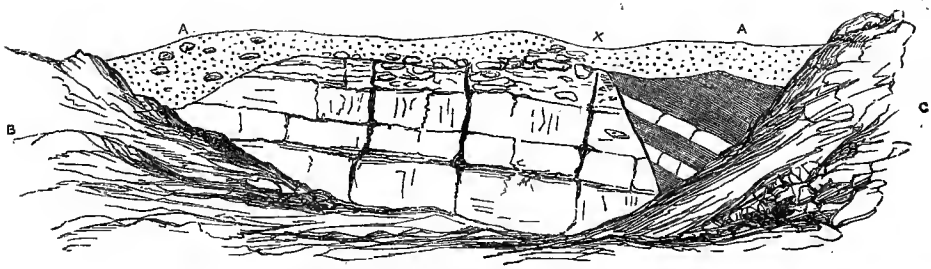
The following section was laid open in a pit in the garden of the Banbury workhouse:

	ft.	in.	
Vegetable soil and clay.	2	6	
Hard, white, earthy limestone.	0	6	Basement beds of the Upper Lias.
Blue clay.	2	6	
White earthy limestone.	0	4	
Clay, with a bed of carthy limestone.	5	0	
Marlstone rock bed.			

The Lias beds crop out by the roadside just below the workhouse.

A quarry, a quarter of a mile south of Thenford, on the road to Great Purston, now filled up, also showed a small patch of these beds very well. A sketch of it is given below.

Fig. 1.
Section in a Quarry S. of Thenford.



A. Rubble and surface soil.
B. Marlstone Rock Bed.
C. Upper Lias clays with two beds of carthy limestone.
x Fault.

In the village of Marston St. Lawrence, some bands of very hard, blue, flaggy limestone, with blue shaly clays between, crop out by the

roadside, close by the "n" of the word "Marston." They lie just about the junction of the Upper Lias and Marlstone, and may perhaps represent, under an exceptional form, the basement beds of the former.

These beds were also noticed by Mr. Hull near Chaddington, where they contained *Ammonites annulatus*, *A. serpentinus*, *A. communis*, and *Gresslya Anglicana*.*

The above are but a few of the outliers of Upper Lias that lie thickly scattered over the Marlstone plateau, saved from denudation by a slight rise in the ground, or by a down-throw fault. In many cases the thickness of these remnants is not more than a few feet; they are however of some interest as showing well the lowest beds of the formation.†

Sections are seldom found in the upper part of this formation, nor are fossils plentiful. A bed of blue, earthy, limestone, about one foot thick, and somewhat concretionary, may be seen in the railway cutting north-west of Cockley Hill, and the clay is worked in brick pits under Thenford Camp, and between Turweston and Brackley.

"Along the valleys of the Evenlode and its branches the Upper Lias forms a zone of moist ground, producing springs. Sections however are seldom seen.

"The formation varies in thickness from about 40 feet in the neighbourhood of Sarsden to five feet at Fawler (see section on p. 7); we may therefore believe that in the Woodstock district we probably reach the south-easterly limit of the Upper Lias."‡

CHAPTER III.
LOWER OOLITES.

Inferior Oolite.

"This formation, which, at the western edge of the Cotteswold Hills, near Cheltenham, consists of several members, attaining a combined thickness of 264 feet, is represented in the present district by only the highest member of the series, containing a large sea-urchin (*Clypeus Plotii*), which is found wherever these beds occur. The lithological character of this subdivision is everywhere similar, and the beds are plentifully stored with their characteristic fossils. It may be described as a coarse-grained oolitic limestone, of a yellow or brown colour, a loose friable texture, and very fossiliferous. Near the surface it breaks up into a rubble of rounded fragments, and from this character, as well as from the large size of the oolitic grains, it forms a contrast to the overlying beds of the Great Oolite, which have a tendency to break up into slabs and slates."§

The outcrop of the Inferior Oolite runs in a narrow strip along each side of the valley of the Evenlode from Ashford Mills upwards, and winds round by Chipping Norton till it abuts against a fault at Colls Combe Barn: outliers of it occur at Little Rollwright, and it breaks out in the sides of the hollows above the Liassic inlier of Heythrop and Enstone.

* Geol. of the Country round Woodstock (Mems. of Geol. Survey), p. 12.

† It is hoped that every one of these little outliers, that could be seen in quarries or otherwise at the time the Survey was made, has been laid down on the map; but it may well be that others will be brought to light, as fresh sections are opened. Observers constantly on the spot can alone hope to map the whole of them.

‡ Geology of the Country round Woodstock, p. 12.

§ Geology of Country round Woodstock, p. 12, 13.

"The sections in the Inferior Oolite, though numerous, are seldom good, but the rock makes it appearance more or less clearly in all the roads which cross it along the valley of the Evenlode.

"At Churchill, along the road to Chipping Norton, there are several quarries, in which the rock is very fossiliferous, containing *Ammonites Murchisoniæ*, *Pholadomya* (two or three species), *Myacites*, *Lima gibbosa* (a characteristic fossil), *Pecten*, *Terebratula globata*, *Clypeus Plotii*, *Nucleolites clunicularis* (?). There is a quarry opened in Sarsden Park showing the lowest beds. In the sections along the roads on the north side of the valley opposite Ascott the same fossils occur plentifully. At Chaddington a beautiful spring bursts out at its base, and springs rise in a similar position at Dean, Spilsbury, and Taston.

"Along the base of the picturesque dell which runs far up into the heart of Wychwood Forest, and along the sides of Charlbury Park, the junction of the Upper Lias Clay and the Inferior Oolite is indicated by copious springs and marshy ground. Small sections of the Oolite crop out occasionally with the usual fossils, especially at a bend in the valley called Buckleaf, where I found *Trigonia costata*, *Myacites*, *Terebratula globata*, and *Anabacia* (an oval species). The stratum is very thin, and consists of large-grained, rubbly oolite. Sections occur in the railway cuttings south of Charlbury, also at Fawler, and in the lane leading from Wilcote to Ashford Bridge, on the up-throw side of the fault. On the bank of the Evenlode, south of Stonesfield, a few square yards are brought to the surface by a fault; and the beds, which are of the usual character, and very fossiliferous, are well shown in a natural cliff. They dip south at about 6°, and are soon lost under the beds of the Great Oolite. This is the most easterly spot in the district where the Inferior Oolite reaches the surface."*

In tracing the Lias and the Inferior Oolite from the neighbourhood of Cheltenham into the present district, Mr. Hull has found a large and rapid falling off in the thickness of these formations. The following table, taken from his Memoir on the Country round Woodstock, embodies the general result of his observations; for fuller particulars the reader may turn to the memoir quoted, p. 14; to the Memoir on the Geology of the Country round Cheltenham, p. 21, 22; and to a paper by Mr. Hull read before the British Association at Cheltenham in 1856.

TABLE of COMPARATIVE SECTIONS.

CHELTENHAM.			CHARLBURY.		
Formation.	Subdivision.	Thickness in feet.	Formation.	Subdivision.	Thickness in feet.
Inferior Oolite 264 feet.	*a.* Ragstone. *b.* Upper freestone. *c.* Oolitic marl. *d.* Lower freestone. *e.* Pea grit.	38 34 7 147 38	Inferior Oolite 5 to 10 feet.	*a.* Ragstone. *b.* Absent. *c.* Absent. *d.* Absent. *e.* Absent.	5 to 10
Ammonite Sands.	*f.*	20 to 30		*f.* Absent.	
Upper Lias 230 feet.	*g.* Blue shale.	202	Upper Lias 10 feet.	*g.*	10
Marlstone 116 feet.	*h.* Rock bed. *h*¹. Sands.	6 110	Marlstone 16 feet.	*h.* Rock bed. *h*¹. Sands.	6 10
Lower Lias.	Lower Lias shale. (about) Limestone.	600	Lower Lias.	Thickness unknown.	

* Geology of the Country round Woodstock, p. 13.

It may be as well here to mention that we now have evidence which seems to point to a like thinning out, for some distance at least, of the Upper Band of the Great Oolite, the Forest Marble, and the Cornbrash towards the north-east. It will be seen below that we lose all, or nearly all, trace of the Forest Marble within the present sheet; and in surveying the map 52 S.W., Mr. Howell found that on the south-west of Bedford the Cornbrash is entirely gone, and the Great Oolite much lessened in thickness.

Fossils from the Inferior Oolite at Fawler and Stonesfield (Bank of Evenlode).*

Fossils.	Fawler.	Stonesfield.	Fossils.	Fawler.	Stonesfield.
Cœlenterata.			*Pecten lens*, Sow.	+	+
Montlivaltia		+	*Isocardia*	+	+
			Astarte		+
Echinodermata.			*Homomya gibbosa* (Sow.)	+	
			Modiola gibbosa (Sow.)	+	
Clypeus Plottii (Klein)		+	*Cypricardia cordiiformis* (Desh.)		+
Holectypus depressus (Lam.)		+	*Gomomya v. scripta* (Goldf.)	+	
			Myacites Jurassi (Brong.)	+	
Brachiopoda.			*Trigonia costata* (Sow.)	+	
			Pholadomya fidicula (Sow.)	+	
Terebratula perovalis, Sow.	+	+	*Panopæa*		+
T. maxillata, Sow.		+			
T. sphæroidalis, Sow.	+		Gasteropoda.		
Rhynchonella concinna, Sow.	+	+			
			Nerinæa		+
Lamellibranchiata.			*Littornia*	+	
			Cephalopoda.		
Ostrea		+			
Lima		+	*Ammonites Parkinsoni* (Sow.)	+	

Great or Bath Oolite.

Under this head we shall treat by itself each of the two zones or bands into which this formation has been divided by Mr. Hull.

Lower Band of the Great Oolite; Stonesfield Slate or Northampton Sands.

The lower band is represented in the north of our district by sandy beds, mostly loose and iron-stained, but in places bound together by carbonate of lime into hard, unevenly-bedded, slaty sandstones. These beds are now known as the Northampton Sands.

A belt of these sands, varying in width with the slope of the ground, runs at the foot of the escarpment of the limestones of the Upper Band, along the whole of its length. They also cap Epwell and Crouch Hills and other outliers to the south-west and west of Banbury.

The sands being for the most part unfossiliferous, their position alone can give a clue to their age, and resting as they do on the Upper Lias Clay, they were long looked upon as holding the place of the beds now known as the Upper Lias Sands of Gloucestershire, and were with them classed with the Inferior Oolite.† While surveying the neighbourhood of Banbury Mr. Polwhele was led to think that they belonged rather to the base of the Great Oolite; and this conjecture has been since fully borne out

* The species not named were in the form of casts.

† Histoire des Progrès de la Géologie, A. D'Archiac, vol. vi. p. 80.

by the afterwork of himself and other observers;* and all doubt as to their age was at last set at rest by the discovery of the following fossils in them near Deddington.

Fossils from the Northampton Sands, near Deddington.

Echinodermata.

Echinobrissus clunicularis, Llhwyd.

Brachiopoda.

Terebratula maxillata, Sow.
Rhynchonella varians, Schloth.
R. concinna, Sow.

Lamellibranchiata.

Hinnites velatus, Goldf.
Ostrea Sowerbyi, Lyc. and Mor.
Pecten annulatus, Sow.
Trigonia Moretoni, Lyc. and Mor.
Cardium Buckmanni, Lyc. and Mor.
C. Stricklandi, Lyc. and Mor.
Cypricardia Bathonica, D'Orb.

The typical locality for these beds is the neighbourhood of Northampton, whence their name, and they there reach their full thickness. They have already been traced along their outcrop as far as Chipping Norton on the south-west and Kettering on the north-east: they seem however to thin away fast in the direction of the dip, being altogether wanting north of Stony Stratford, only six inches thick near Helmedon,† and very thin about Heyford on each side of the valley of the Cherwell.‡

These sands are of so marked a stamp, that, even where quarries or deep sections cannot be had, they may be well studied in ditches or by the fragments turned up in ploughed fields. Between Brackley and Whitfield, and south-west of the former place, slaty beds are found in plenty; about Farthinghoe, where a broad spread of the formation occurs, it is more sandy, as also round Newbottle, Aynho, and Croughton. Near Aynho we find immediately below the limestones of the Upper Band finely-laminated, flaggy sandstones, and under these beds of loose white and brown sand.§ On the outliers on the other side of Banbury sand mostly prevails.

"In the valley of the Dorne we find beds of yellow ferruginous sands passing upwards into calcareous sandstone at the base of the oolite and resting upon the Upper Lias Clay. These are well shown at Steeple Barton on the east side of the river, where they are 30 feet thick, and may be traced as far south as Linch Farm. The same beds are shown along the turnpike road east of Hopcrofts Holt, in the bank, resting on Lias Clay; also in the same road at Lower Heyford and at North Brook Farm."‖

The following sections taken from a paper by Prof. Phillips, in the 16th vol. of the "Quarterly Journal of the Geol. Soc." show the position and nature of these beds.

Junction of the Lias and Oolite, N. of Oxford.

g. Oolite, compact, marly, or shelly.
f. Oolite of a rough shelly character.
e. Marly clay.
d. Brown ferruginous sands and sandstone, with calcareous and irony layers, 13 feet.
c. Upper Lias Clay containing a band of ironstone nodules (*Ammonites bifrons, A. heterophyllus, Belemnites, &c.*), 35 feet.
b. Marlstone, solid and ferruginous, 20 feet.
a. Middle Lias Clay.

* See also the Memoirs of the Geol. Survey on Maps 53 S.E. p. 8, 9, and 53 N.E. p. 9, by Mr. Aveline.
† Note by the late Mr. R. Trench.
‡ Geology of Country round Woodstock, p. 17.
§ From the Note-book of Mr. T. R. Polwhele.
‖ Geology of the Country round Woodstock, p. 17.

Prof. Phillips also gives the following detailed section of *d* at Worton between Steeple Ashton and Banbury.

	ft.	in.
" Small shells and sand, resting either on limited patches of calcareous sandstone (' plank '), or on iron ore - -	4	0
Oolitic iron ore in undulated and folded masses - -	0	6
Stony bands, with plants - - - - -	1	0
Sands with nodules of iron ore and shells - - -	5	6
Calcareous band - - - - -	2	0
Water issuing from ferruginous clay (top of Lias).		

In the country about Sandford the beds marked *d* become white and yellow sand (16 or more feet thick) with irregular laminæ of calcareous sandstone, more or less blue in the centre, called plank. This is sometimes covered by six feet of clay."*

On the south of our district the beds known to geologists as the Stonesfield slate take the place of the Northampton Sands. "They "consist of a variable series of strata, principally made up of shelly "oolite, sandy limestone, and laminated sandstones, splitting readily "along the planes of bedding, and at Stonesfield producing the cele- "brated 'slates' of that name. These beds reach their greatest thick- "ness along the western part of the district, and thin away towards "the valley of the Cherwell, where they seem on the point of dis- "appearing in a manner similar to the Inferior Oolite.

"At Sarsden there are several quarries, and from one of these, north of Castle Barn, the Earl of Ducie has obtained a specimen of the lower jaw, with teeth, of a Pterodactyle, which Prof. Huxley considers, until further evidence, as belonging to *Rhamphorhynchus Buchlandi*. From the same quarry bones of saurian reptiles and fish remains have been extracted.

"At Lyneham Barrow, near Sarsden, the beds of the lower zone are well shown in two quarries. They consist of white and yellow oolitic limestone, fissile when exposed to the air, and sometimes false bedded. Many of the beds are composed of the débris of shells, while others are more compact. In the joints a soft white mineral occurs which is probably allied to allophane. In a quarry on the west side of the Chipping Norton road at the head of the Sarsden valley the same beds are shown, but they are more regularly stratified.

"There are also quarries and road sections along the south side of the Evenlode valley, but everywhere the strata are of a similar cha racter to those described. They attain a thickness of about 100 feet, and though they seldom prove good building stone here, yet the same beds at Tainton, near Burford, produce the best building stone in the country.

"There are also good sections in the railway cuttings near Ashford Bridge and Westfield Farm; in the latter of which a coral band may be found about 10 feet from the ground. Similar shelly oolites compose the strata immediately above the bands which are worked for slate at Stonesfield."†

It would be impossible in a small tract like the present to give anything like its due to so famous a formation as the Stonesfield Slate, which has besides been already fully described by abler hands in the papers quoted below.‡

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* Prof. Phillips. Quarterly Journal of Geol. Soc. vol. xvi. p. 116.

† Geology of the Country round Woodstock, pp. 16, 17.

‡ Fitton, Zoolog. Journal, vol. iii. p. 412; Murchison, Geology of Cheltenham; Lonsdale, Proceedings of Geol. Soc. vol. i. p. 414; Brodie and Buckman, Journal of

Fossils from the Stonesfield Slate.*

PLANTÆ.

Halymenites ramulosus, Sternb.
Fucoides furcatus, Brong.
Sphænopteris cysteoides, Lind.
Hymenophyllites macrophylla, Göpp.
Tæniopteris latifolia, Brong.
T. scitaminea, Sternb. *T. vittata*, Foss. Flora, *t.* 176, *f.* B.
Palæozamia pectinata, Brong.
P. taxina, Lindl.
Zamites lanceolatus, Lindl.
Pterophyllum comptum, Lindl.
P. minus, Brong.
Taxites podocarpoides, Brong.
Thuytes articulatus, Sternb.
T. cupressiformis, Sternb.
T. divaricatus, Sternb.
T. expansus, Sternb.
Bucklandia squamosa, Brong.
Carpolithes.

ANIMALIA.

CŒLENTERATA.

Actinozoa.

Anabacia orbulites, Lam.
Thamnastrea Lyelli, Edw.
Isastræa, 2 species.

ANNULOSA.

Echinodermata.

Hemicidaris.
Clypeus Plotii, Klein. W.
Pseudodiadema Parkinsoni, Wright. W.

Annelida.

Serpula, small sp.

MOLLUSCA.

Brachiopoda.

Rhynchonella farcta, Linn.
R. obsoleta, Dav.
R. concinna, Sow.
Terebratula maxillata, Sow.

Lamellibranchiata.

Gervillia acuta, Sow.
G. subcylindrica, L. & M.
G. ovata, Sow.
Perna rugosa, Goldf.
Pteroperna pygmæa, Koch & Dunk. W.
Inoceramus amygdaloides, Goldf.
I. obliquus, L. & M.
Lima cardiiformis, L. & M.
L. duplicata, Sow.
L. impressa, L. & M.
L. proboscidea.
Pinna ampla, Sow.
P. cuneata, Bean.
Placunopsis socialis, L. & M. W
Pecten lens, Sow.
P. vagans, Sow.
P. personatus, Goldf. W.
P. annulatus, Sow.
P. retiferus, L. & M. W.
Ostrea Sowerbyi, L. & M.
O. acuminata, Sow.
O. gregaria, Sow.
Hinnites abjectus, Phill.
Modiola plicata, Sow.
M. compressa, Portlock. W.
M. imbricata, Sow.
Mytilus sublævis, Sow.
Pholadomya acuticosta, Sow.
P. Murchisoni? Sow.
Trigonia costata, Sow.
T. impressa, Sow.
T. Moretoni, L. & M.
Astarte elegans, Sow.
A. Waltoni, L. & Mor.
A. angulata, L. & Mor.
A. squamula, D'Arch. W.
A. pumila, Sow. W.
Unicardium.
Cardium acutangulum, Phil.
C. Stricklandi, L. & Mor. W.
Mya (Myacites) calceiformis, Phil.
Opis lunulatus, Sow. W.
Tancredia brevis, L. & M.
T. curtansata, Phill. W.
Quenstedtia oblita, L. & M. W.
Corbula involuta, Goldf. W.

Geol. Soc. vol. i. p. 220. Notices of the fossils of the Stonesfield slate will be found in the following papers: Buckland, Transactions of Geol. Soc. 2d series, vol. i. p. 390 ; Buckland, Proceedings of Geol. Soc. vol. ii. p. 688 ; Buckland, Bridgwater Treatise, vol. i. pp. 121, 221, 234, 258, 260, 265, 319 ; Broderip, Zoolog. Journal, vol. iii. p. 408 ; Ogilby, Proceedings of Geol. Soc. vol. iii. p. 21 ; Owen, Transactions of Geol. Soc. 2d series, vol. vi. p. 47, 58 ; Huxley, Journal of Geol. Soc. vol. xv. p. 658 ; Phillips, Oxford Essays, 1855.

* This list was compiled by Professor Phillips and appeared in the Oxford Essays for 1855. Its importance and completeness renders it necessary to embody it in this memoir in full. The species marked W are given on the authority of Mr. Whiteaves.

GASTEROPODA.

Chemnitzia Hamptonensis, L. & M.
Alaria trifida, Phil.
Natica, 2 species.
Actæonina.
Turbo.
Patella rugosa, Sow.
P. Rœmeri? L. & M.
Eulima communis, L. & M. W.
Nerita hemispherica, Rœm. W.
N. minuta, Sow. W.
N. costulata, Desh. W.
N. rugosa, L. & M. W.
Trochus spiratus, D'Arch. W.

CEPHALOPODA.

Nautilus Baberi, L. & M.
Ammonites gracilis, Buck.
A. Waterhousei, M. & L. W.
Belemnites fusiformis, Park.
B. Bessinus, D'Orb.

VERTEBRATA.

PISCES.

(PLACOIDEI.)

Cestraciontidæ.

Acrodus leiodus, Ag.
Asteracanthus semisulcatus, Ag.
Ceratodus Phillipsii, Ag.
Leptacanthus semistriatus, Ag.
L. serratus, Ag.
Nemacanthus brevispinus, Ag.
Strophodus favosus, Ag.
S. magnus, Ag.
S. tenuis, Ag.
Pristacanthus securis, Ag.

Hybodontidæ.

Hybodus apicalis, Ag.
H. dorsalis, Ag.
H. grossiconus, Ag.
H. marginalis, Ag.
H. polyprion, Ag.

Edaphodontidæ.

Ganodus Bucklandi, Egert.
G. Colei, Buck.
G. curvidens, Egert.
G. dentatus, Egert.
G. emarginatus, Egert.
G. falcatus, Egert.
G. neglectus, Egert.
G. Owenii, Buckl.
G. psittacinus, Egert.
G. rugulosus, Egert.

(GANOIDEI.)

Pycnodontidæ.

Gyrodus perlatus, Ag.
G. trigonus, Ag.
Gyronchus oblongus, Ag.
Pycnodus Bucklandi, Ag.
P. didymus, Ag.
P. Hugii, Ag.
P. latirostres, Ag.
P. obtusus, Ag.
P. ovalis, Ag.
P. parvus, Ag.
P. rugulosus, Ag.
P. trigonus, Ag.
Scaphodus heteromorphus, Ag.

(LEPIDOIDEI.)

Lepidotus tuberculatus, Ag.
L. unguiculatus, Ag.
Pholidophorus minor, Ag.

(SAUROIDEI.)

Belonostomus leptosteus, Ag.
Caturus pleiodus, Ag.
Macrosemius brevirostris, Ag.
Sauropsis mordax, Ag.

(CŒLACANTHI.)

Cheirolepis cyclus, Ag.

REPTILIA.

Megalosaurus Bucklandi, Meyer.
Teleosaurus cadomensis, Groff.
Cetiosaurus medius, Owen.
Pterodactylus Bucklandi, Goldf.
Chelonia.

MAMMALIA.

Amphitherium Broderipi, Owen.
A. Prevostii, Cuv.
Phascolotherium Bucklandi, Brod.
Stereognathus ooliticus.

Upper Band of the Great Oolite.—This is a group of limestones, marls, and clays, which rest upon the beds last described, and, because they are regular in their stratification and the same in composition for long distances, contrast strongly with the false bedding and changeableness of the band below. Also "the limestones are not usually "oolitic, but of a compact, or, where most fossiliferous, of a marly "nature; and though we frequently find only the moulds or casts, "the fossils are seldom fragmentary, and appear to have been buried "under the influence of still water."*

* Geology of the Country round Woodstock, p. 20.

This formation covers a belt of country, of an average width of four miles, reaching from Whichwood to Whittlewood Forest; outlying patches occur which have been let down into the Marlstone by faults, as at Tadmarton and north of Hook Norton; and it caps some of the outliers of Upper Lias, which have been already mentioned as lying scattered over the Marlstone plateau.

At or near the base beds of dark blue clay often occur. They may be seen in a quarry, half a mile S. of Helmedon, and in a quarry about half way between Brackley and Radston, where the section below was laid open :—

	ft.	in.	
Soft whitish sandstone, breaking into small angular blocks.	2	0	Upper Band.
Clayey sand with broken bits of oysters.	2	0	
Dark blue clay.	1	6	
Hard rubbly sand full of fossils.	2	6	
Hard blue limestone.	2	0	
Flaggy or slaty sandstone.	Lower Band.		

Another spot is given in the following note by Mr. T. R. Polwhele: "At Souldern, north-west of the Toll Gate, the upper bed of the Northampton Sands passes into blue clayey sand, and then into stiff blue clay, the whole overlaid by flaggy beds of the Great Oolite."

Beds of clay on a similar horizon were pointed out to me by Mr. Howell near Northampton.

The middle and largest part of the formation is made up of cream-coloured, rubbly, limestones, often thin-bedded and earthy, which are interstratified with and pass into rubbly marls.

At the top lie beds of pure-white, hard, fine-grained limestones; not that such beds are found only in this place, but they occur there in greater force than elsewhere throughout the Band.

"Commencing at the western side of the district, we find the white limestone composing a considerable portion of the ridge which forms the northern boundary of Whichwood Forest, overlooking the valley of the Evenlode. It may be seen in some quarries below High Lodge. There are also quarries along the road between Ranger's Lodge and Seafield. Near Witney there are several good sections, of which we may mention one by the Cheltenham road, above Minster Lovel, showing the superposition of the Forest Marble. There are also quarries, in a nearly similar stratigraphical position, by the roads to Crawley and Hailey. All over this district the character of the beds is the same, consisting of regularly bedded white limestones, with partings of marl and shale.

"At the village of Bladon, near Woodstock, the beds of white limestone may be observed in some old quarries; and in the bank of the river Glyme, on the north side of Woodstock, a bed of dark carbonaceous clay occurs between two beds of marly limestone, and is a very constant feature over the district. It may be observed in the railway cutting at Kirklington station, where we have the following section, for which I am indebted to Professor Phillips :—

	ft.	in.
1. Cornbrash. Shown in quarries above the railway.	8	0
2. Forest Marble. *a.* Pale clays and interrupted thin laminæ of shelly Forest Marble.	12	0
3. Great Oolite. *b.* Solid shelly oolite; top oolitic, middle close-grained, base sandy.	3	9
c. Sandy and marly bed.	0	6
d. Dark laminated clay, plants, jet, *Cyrena*.	0	10
e. Pale blue clay, with calcareous nodules.	0	8

	ft.	in.
f. Dark clay, with plants, jet.	0	8
g. Pale-blue and brown clay.	1	5
h. Sandy layer.	0	6
k. Oolite, pale, unequally grained, with waterworn top, sometimes drilled by *Lithodomus;* univalves, covered by drifted *Terebratula maxillata,* and *Ostrea crassa.* Thin parting.	2	4
l. Oolite, white, and of variable texture.	2	6
m. Oolite, full of *Terebratula maxillata.**	3	0

"On the right bank of the river, in a semicircular cliff, partly natural, we obtain the following section of the upper zone.

"*Section of the Great Oolite; Upper Zone. Enslow Bridge.*

	ft.	in.
a. Grey marl and marlstone.	4	0
b. Hard, compact, grey limestone: *Terebratula, Ostrea.*	2	0
c. Blue and greenish marl, with shaly bands, full of oysters and carbonized wood.	5	0
d. White, compact limestone, in thick beds, with *Cardium, Modiola, Lima,* &c.	6	0
e. Terebratula bed, made up almost exclusively of *Terebratula maxillata,* imbedded in marly limestone.	5	0
f. White limestone, slightly oolitic, and evenly bedded; burnt for lime.	12	0
g. Soft white fossiliferous marl.	2	6
h. White limestone (base not visible).		

"The most remarkable feature in this fine section is the bed (*e*), five feet thick, occupying a central position in the cliff, and made up almost entirely of *Terebratulæ*. They are in excellent preservation, and of all sizes.

"At Tackley the basement beds of the Upper Zone, with *Ostrea Sowerbyi, Pecten annulatus, Panopæa,* and *Rhynchonella,* consist of about 20 feet of shales and marls, which are succeeded by white limestone, all of which may be seen in the railway cuttings. The marls rest on the limestone bed of the lower zone, below which is a bed of sand, with water, resting on the clay of the Upper Lias. A similar succession may be seen in quarries at Berring's Wood, south of Over Kiddington.

"In a quarry at Maiden Bower, above Rousham, the beds appear to have a dip south-west at 5°, from what cause cannot be determined. The beds are very soft, full of fossils, principally as casts. White limestones of a similar character form the higher grounds around Kiddington, Ditchley, and Stonesfield.

"The shales and marls at the base of the upper zone may also be seen in a quarry in a fir wood by the roadside, north of Tackley Wood. *Rhynchonella concinna, Terebratula, Pholadomya, Modiola,* and *Ostrea Sowerbyi* are plentiful here."†

The white limestones are largely quarried about Souldern, Croughton, and Aynho; the escarpment is much broken by faults, and the beds are shaken about and tilted. The section below was sketched in a quarry east of the toll-gate at Souldern, by Mr. T. R. Polwhele.

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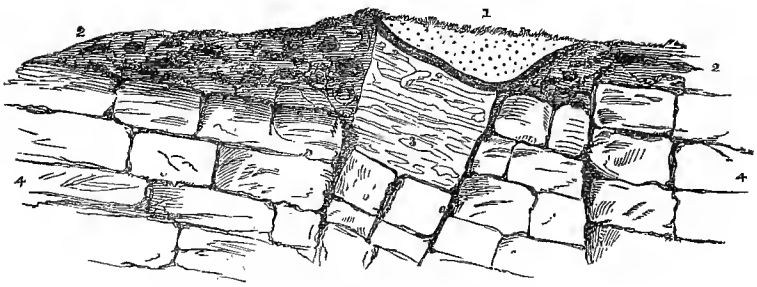
* Prof. Phillips draws the line between the Forest Marble and Great Oolite at the base of the bed marked *h*; the solid white limestone, marked *b*, has been taken by the Geological Survey as the type of the Great Oolite, and I have therefore ventured to change the classification to make it agree with that used in other publications of the Survey.

† Geology of the Country round Woodstock, p. 20, 21.

Fig. 2.—Section at Souldern.



1. Vegetable soil resting on a band of clay.
2. Rubble.
3. White marl.
4. Freestone.

Tilted beds may also be seen in a quarry in Aynho Park, dipping north-west at 10°.

At Hethe we have the following section in the uppermost beds :

	ft.	in.
Surface soil with fragments of Cornbrash.	3	0
Laminated, dirty-blue clay, full of oysters.	4	0
White rubbly marl.	2	0
Hard, solid, white limestone.	3	0
Interval, hidden by fallen rubbish.	2	0
Brown, rubbly limestone, with shells.	0	9
Brown clay.	0	3
Hard, solid, white limestone.	5	0

On the road from Croughton to Buckingham, a little to the east of Monks House, are large quarries in the middle beds ; they gave the following section :

	ft.	in.
Soil.	1	0
1. Flaggy limestone.	2	0
2. Sandy clay.	1	6
3. White, flaggy limestone.	1	6
4. Hard, white, sandy limestone.	1	0
5. Soft sandstone, passing into.	0	3
6. Hard, white, sandy limestone.	3	0
Water.		

(5) contained many shells, *Pteroperna*, &c.

Like beds have been largely worked about Mixbury ; a quarry to the east of the church showed :

	ft.	in.
Rubbly limestone.		
White freestone, with layers of hard limestone.	3	6
Yellow clay. } Oysters. Blue clay. }	1	3
White limestone.	1	0
Yellow, sandy clay.	0	9
Hard, cream-coloured limestone.	1	6

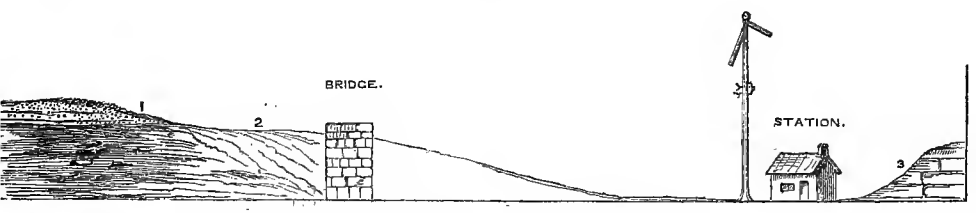
A quarry about halfway between Mixbury and Evenly Green gave the section below :

	ft.	in.
Yellow rubbly limestone and marl, full of fossils.	4	0
Thin-bedded, sandy limestone.	1	6

	ft.	in.
Yellow oolitic limestone: whitish with pink grains when fresh broken. - - -	0 0 to	0 3
Yellow clay, with oysters. - -		0 9
Yellow freestone. - -		1 0
Thick-bedded, hard, yellow limestone. - -		3 6

Near Brackley a group of faults again breaks up the beds. Of these, the one running nearly due east from Hinton-on-the-Hedges crosses the railway cutting immediately to the north-west of Brackley Station, as the sketch below shows :

Fig. 3.



1. Sand and slaty sandstone. Northampton Sands.
2. Upper Lias Clay with nodules of earthy limestone.
3. Marls and limestones of the Great Oolite.

It is next seen in the road to Hinton-on-the-Hedges. At the first brook after leaving Brackley, Great Oolite was shown on the east bank, and Lias Clay capped by the Sands, on slightly *higher* ground, close on the other side. Some Great Oolite beds in a quarry on the hill-top by the same road are shattered, and dip N.N.W., tilted most likely by this fault. Further to the west the fault brings Lias Clay (shown in ditches by the roadside) against Northampton Sands, which on the south side of the fault reach right across the valley. The fault, branching out of this on its south side, and running parallel to the railway, is drawn to account for the abutting of the Lias Clay on its south side, against the Great Oolite limestone on the north, the latter forming a little cliff by the brook side, and dipping north-east, and the former having been turned up in drains close by. The line of this fault, produced for about four miles, passes by a cutting in the railway where the beds are broken and dip S.S.W., at an angle of 15°. It is therefore possible that the valley of the Ouse between these points may coincide with a line of fault, but evidence is wanting to make us sure of this. The fault running S.S.W. from Whitfield is nowhere seen, but that some such break exists is clear enough. The Lias Clay is found down to the bottom of the valley, and is worked in a brick pit on its west side, while on the east bank Great Oolite beds reach everywhere close down to the river, here and there dipping higher than usual. The fault has been drawn on the north as far as a quarry on the west side of Whitfield church, where the beds are broken ; southwards it would, if produced, fall into a line of fault running by Hethe Braid and Beanton. The want of all evidence over the ground between forbids their being joined up at present. The little fault running W.N.W. through Brackley Church rests on somewhat slender evidence, but in a lane side some sandy beds, like Northampton Sands, were seen on a level with Great Oolite limestone.

Between Brackley and Buckingham sections are very plentiful. On the south side of the road a little before the turn to Westbury fine sea

urchins and many other fossils occurred in a small quarry. Sixteen chains west of this, lower down the hill, is another quarry, showing the following beds :—

	ft.	in.
Traces of a bed of hard, blue, flaggy, oolitic limestone.		
Hard yellow rubbly marl, with *Rhynchonella concinna* and other shells in plenty: lime cemented at bottom.	5	0
Dirty-blue clay, with oysters.	3	6
Hard, flaggy, reddish-brown, shelly limestone.	4	6

By the second brook after leaving Westbury are large quarries, giving the following section :

	ft.	in.
Rubble.	4	0
Brown clay.	0	7
Soft yellow sandstone.	0	6
Hard white limestone.	0	6
Yellow sand.	0	6
Soft white sandstone.	0	6
Hard white limestone.	1	1
Soft yellow sandstone.	2	6

In a quarry north of Shalstone Hill Farm was yellowish rubbly clay, resting on a bed of very hard white limestone, made up almost entirely of broken shells, and yielding a beautiful building stone.

At Bufflers Holt :

	ft.	in.
Soil.	2	0
Dark-blue clay.	4	0
Yellow, rubbly clay.	1	0
Hard, cream-coloured limestone.	1	0
Buff-coloured clay, oysters.	1	6
Thick-bedded, hard, grey limestone. (*Nucleolites clunicularis*, &c.)	5	0
Sand.	0	4
Hard, white limestone.	3	0

Turning hence along the valley to the north, we find north of the "y" in Boycot :

	ft.	in.
Soil.	2	0
Hard, whitish limestone.	2	0
Hard, flaggy grey limestone.	1	2
White sand.	0	4
Cream-coloured flaggy limestone, much broken by joints. (*Lima cardiiformis.*)	1	7
Alternations of white rubbly marl and white limestone.	4	0
Hard, flaggy, yellow limestone.	0	6
Whitish, rubbly limestone.	2	0
White marl, lumpy in the upper part, laminated below.	3	0

The beds dip to the west at 4°, roll slightly, and are broken by a very small fault, with an open fissure filled in by gravel.

About half a mile higher up the valley, by Hogholes Farm :

	ft.	in.
Fine gravel and sand.	1	6
Blue Boulder Clay.	4	0
Hard, flaggy, whitish limestone.	1	0
White, sandy clay and rubble.	2	0
Dark, bluish-black clay.	5	0
White shelly limestone and yellow sandstone.	4	0

In the strip of Great Oolite running along the valley of the Ouse we have the following sections.

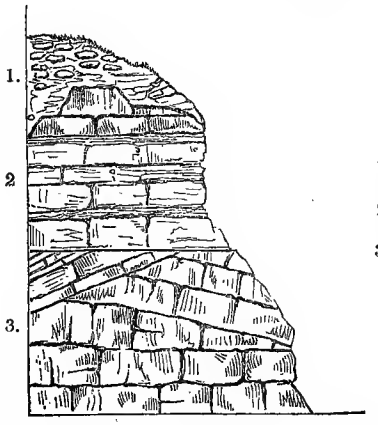
At Radcliff:

	ft.	in.
Rubble and soil.	1	0
Clay, white, yellow, blue and black (oysters).	3	0
Hard, solid white limestone. (*Modiola imbricata*).	3	9
White marl.	0	3
Brown clay.	0	3
Rubbly white marls and limestones.	2	0

These are most likely the topmost beds.

At Maids Morton Mill is a little quarry, and farther to the east, on the road from Thornborough to Leckhampstead, the section below, the beds of which are close at the top of the series, Cornbrash showing immediately above in the ditch.

Fig. 4.



	ft.	in.
1. Rubble and brown sandy oolite.	6	0
2. Soft white rubbly limestones and clays.	5	0
3. Brown sandy oolite, false bedded.	8	0

In the valley of the Thornborough brook the large quarries near the Brick-kiln gave the following fine section:

	ft.	in.
Cornbrash rubble.	2	0
White marly limestone.	0	6
Brown clay.	2	6
White marl.	3	0
Stiff blue clay.	4	0
Hard, grey, evenly-bedded limestone.	1	6
Clay.	1	6
Hard, brown, evenly-bedded limestone.	1	6
Rubbly marl, with shells.	2	0
Hard, whitish limestone.	3	6
White sand.	0	9
White sandstone.	2	0
Sandy clay.	0	9
Hard, brown limestone.	0	6
Clay.	0	9
Hard, cream-coloured limestone.	2	0
Cream-coloured rubbly marl (*Lima cardiiformis*).	4	0

A fault, with a downthrow to the east of ten feet, runs across the quarry, throwing out the Cornbrash on the west. The four beds of marl and clay below the Cornbrash may possibly represent the Forest Marble, the remainder belongs to the Great Oolite.

In the Leckhampstead valley the beds are much faulted ; the sketch below was taken in a quarry near South End.

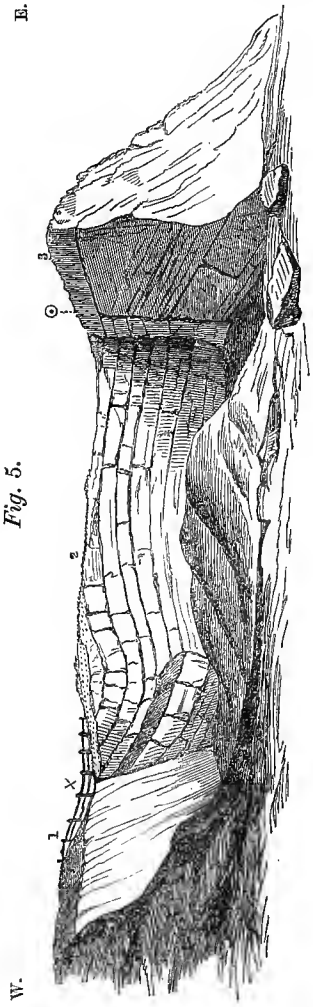


Fig. 5.

1. White rubbly marl.
2. Hard whitish limestone.
3. White flaggy sandstone on a thick bed of hard white sandstone.
× Fault, bearing N. & S. nearly.
⊙ Fault, bearing E. & W. nearly.

Disturbed beds may also be seen at the west end of Leckhampstead, by the brook-side, and on the road leading northwards.

Over the drift-covered country on the north-east of the map sections are of course fewer. The Great Oolite is quarried at Silverstone, and is largely worked round Wicken. In Long Copse, N.N.W. of that village, the beds are rich in fossils, among them *Modiola imbricata*, *Ostrea Sowerbyi*, *Trigonia Moretoni*, and *Unicardium varicosum*. A little to the east of this, in a brick-pit, are the following beds :—

Very fine gravel and pale-blue clay interstratified. Drift.
Dark-blue shaly clay, very finely laminated.

The lower bed is said to have been proved to a depth of 36 feet, without reaching the bottom. There are sections hard by which show

that the clay cannot keep this thickness for far, and, if the account be true, the bed must be of a lenticular shape. I have nowhere else in this country seen Great Oolite clays of the same nature and thickness.

Upon the whole the Upper Band of the Great Oolite seems to lose somewhat of its regularity and to become more sandy and earthy towards the north-east. As the formation is known to be thinning in that direction, this is only what might be looked for.

In the Woodstock district Mr. Hull put down the Upper Band of the Great Oolite at 100, and the Lower at 80 feet. Mr. George Glen, of Stratton Audley, told me that a boring in search of coal was made in that village to a depth of 243 feet 10 inches, and that a plentiful and regular spring of water, of the same temperature all the year round, now flows from the bore hole. The boring started in the Cornbrash, and it would seem likely that the water comes either from the Northampton Sands or the Marlstone. The former has, however, probably thinned out by this time, and if it is the Marlstone that yields the water, the Great Oolite would be here at least 200 feet in thickness.

GREAT OOLITE FOSSILS from the Lower Zone exhibited at the Railway Station opposite Stonesfield, and from the Upper Zone at Kirklington Station and Enslow Bridge.* (Whiteaves.)

FOSSILS.	Lower Zone, Stonesfield.	Upper Zone.	
		Kirklington.	Enslow Bridge.
CŒLENTERATA.			
Isastræa explanata, M'Coy	+		
Anabacia orbulites, Lam.		+	
ECHINODERMATA.			
Acrosalenia hemicidaroides, Wright	+	+	
Echinobrissus Woodwardii, Wright	+		
E. Griesbachii, Wright	+		
Clypeus Mulleri, Wright	+		+
C. Plotii, Klein			+
POLYZOA.			
Diastopora diluviana, M. Edw.			
MOLLUSCA.			
BRACHIOPODA.			
Rhynchonella concinna, Scw.	+	+	
R. obsoleta, Sow.	+	+	
Terebratula maxillata, Sow.	+	+	
T. digona, Sow.		+	
LAMELLIBRANCHIATA.			
Ostrea Sowerbyii, L. & M.	+		
O. subrugulosa, L. & M.	+		
O. gregarea, Sow.	+		
O. acuminata, Sow.	+		
Placunopsis socialis, L. & M.	+	+	
Pecten lens, Sow.	+		
P. vagans, Sow.	+		
P. arcuatus, Sow.			+

* The greater portions are from the beds marked *k* in Prof. Phillips' description of the section at Kirklington Station in the section on p. 16.

Fossils.	Lower Zone, Stonesfield.	Upper Zone.	
		Kirkling-ton.	Enslow Bridge.
LAMELLIBRANCHIATA—*cont.*			
P. annulatus, Sow.		+	
Pteroperna costulata, Desh.		+	
P. emarginata, L. & M.		+	
Gervillia acuta, Sow.	+	+	
G. monotis, Desh.		+	
G. ovata, Sow.		+	
G. crassicosta, L. & M.		+	
G. n. sp.	+		
Lima cardiiformis, L. & M.	+	+	
L. duplicata, Sow.	+		
Perna rugosa, L. & M.	+		
Pinna cuneata, Phill.		+	
Modiola imbricata, Sow.	+	+	
Arca Pratii, L. & M.		+	
A. æmula, Phill.	+		
Macrodon Hirsonensis, D'Arch.	+		
Trigonia Moretoni, L. & M.	+		
Cardium Buckmannii, L. & M.	+		
C. Stricklandi, L. & M.	+	+	
C. subtrigonum, L. & M.		+	
C. incertum, Phill.		+	
Nucula Menkii, Rœm.		+	
N. variabilis, Sow.		+	
Limopsis ooliticus, D'Arch.		+	
Lucina striatula, Buvig.		+	
L. cardioides, D'Arch.		+	
Sphæra Madridi, L. & M.		+	
Cypricardia Bathonica, D'Orb.	+		
C. nuculiformis, Rœmer	+		
C. rostrata, Sow.	+	+	
Astarte squamula, D'Arch.		+	
A. Wiltoni, L. & M.		+	
A. extensa, Phill.			+
A. angulata, L. & M.	+		
Cyprina Loweana, L. & M.	+	+	
C. depressiuscula, L. & M.		+	
Tancredia brevis, L. & M.	+		
T. n. sp.	+	+	
Corbula involuta, Goldf.		+	
C. n. sp.		+	
Neæra Ibbetsoni, Morris	+	+	
Myacites Scarburgensis, Phill.			+
M. calaciformis, Phill.		+	
M. decurtatus, Phill.		+	
Pholadomya Heraulti, Ag.	+		+
P. solitaria, L. & M.			+
P. ovulum, L. & M.	+		
GASTEROPODA.			
Stomatia Buvignieri, L. & M.	+		
Monodonta Labadyei, D'Arch.	+	+	
Actæonina olivæformis, Dunker		+	
A. Eulimoides, L. & M.		+	
A. parvula, Rœmer		+	
Cylindrites brevis, L. & M.		+	
C. n. sp.		+	
Bulla, n. sp.	+		
Trochus Ibbetsoni, L. & M.	+		
T. spiratus, D'Arch.		+	

Fossils.	Lower Zone, Stonesfield.	Upper Zone. Kirklington.	Upper Zone. Enslow Bridge.
GASTEROPODA—*cont.*			
Nerita rugasa, L. & M.	+		
N. costulata, Desh.	+		
N. hemisphærica, Rœmer	+	+	
N. minuta, Sow.		+	
Natica intermedia, L. & M.		+	
Rissoina acuta, Sow.		+	
R. n. sp.		+	
Chemnitzia, n. sp.		+	
Phasianella elegans, L. & M.		+	
P. Leymeriei, D'Arch.		+	
Eulima communis, L. & M.		+	
Ceritella rissoides, Buv.		+	
C. unilineata, Sow.		+	
Nerinæa Eudesii, Desh.		+	
N. Valtzii, Desh.		+	
Cerithium, n. sp.		+	
Alaria trifida, Phil.		+	
A. lævigata, L. & M.		+	
Patella cingulata, Goldf.	+		
CEPHALOPODA.			
Ammonites subcontractus, L. & M.		+	

FOSSILS OF THE GREAT OOLITE.—From Collections made by the Survey.

Fossils.	Stonesfield.	Glympton.	Wootton.	Bladon.	Enslow Bridge.	Blackingrove.	Broughton Fulling Mill.	Banbury.	Buckingham.	Stanford Park.	Woodstock.
CŒLENTERATA (Zoophyta).											
Thamnastræa Lyellii, M. Edw.					+					+	
Convexastræa Waltoni, M. Edw.	+										
Isastræa limitata, Lamk.	+										
ECHINODERMATA.											
Echinobrissus soladurinus, Ag.							+			+	
E. Griesbachii, Wright							+				
Clypeus Mülleri, Wright	+		+		+						
Acrosalenia spinosa, Ag.				+							
A. pustulata, Forbes							+				
A. Wiltoni, Wright							+				
A. hemicidaroides, Wright							+				
CRUSTACEA.											
Astacus							+				
MOLLUSCA.											
BRACHIOPODA.											
Rhynchonella concinna, Sow.	+	+		+	+			+		+	
Terebratula plicata, Buck.						+					+
T. maxillata, Sow.	+	+	+		+		+	+		+	

Fossils.	Stonesfield.	Glympton.	Wootton.	Bladon.	Enslow Bridge.	Blackingrove.	Broughton Fulling Mill.	Banbury.	Buckingham.	Stanford Park.	Woodstock.
Lamellibranchiata.											
Ostrea Sowerbyi, L. & M.		+		+							+
O. gregaria, Sow.		+		+			+				+
Avicula	+										
Pectens vagans, Sow.				+	+				+		
P. fibrosus, Sow.	+			+							
Lima impressa, Lycett		+		+	+				+		
L. cardiiformis, L. & M.									+		
Modiola imbricata, Sow.								+	+		+
M. gibbosa, Sow.	+				+		+				
M. cuneata, Sow.	+				+						
Mytilus sublævis, Sow.			+								
Lithodomus		+							+		
Lucina Bellona, D'Orb.	+				+						
Ceromya Bajociana, D'Orb.					+		+				
Pholadomya Heraulti, Ag.		+	+		+		+				+
P. deltoidea, Sow.			+								+
P. ovalis, Sow.							+				
Sphæra Madridi, L. & M.									+		
Trigonia striata, Sow.		+									
T. costata, Sow.				+	+						
T. Moretoni, L. & M.									+		
Unicardium impressum, L. & M.	+	+			+				+		
Homomya			+								
Isocardia			+								
Panopæa			+								
Astarte aliena, Phil.					+						
Tuncredia axiniformis, Phil.	+										
Cardium Stricklandi, L. & M.									+		
Gasteropoda.											
Nerinæa										+	
Natica cincta, Phil.		+			+	+					
Litorina	+										
Turbo					+						
REPTILIA.											
Teleosaurus					+						

Forest Marble.

"This subformation of the Great Oolite derives its name from Wychwood Forest, of which it forms the greater portion. In its mineral character and fossils it bears a strong resemblance to the lower zone of the Great Oolite. We find similar shelly oolitic limestones traversed by current planes, and similar beds of clay and shale and flagstones, with beds of oysters."*

From Wychwood Forest the outcrop of this rock runs between the plateaus of the Great Oolite and Cornbrash to Bucknell on the north-west of Bicester. The few traces of it that have been found beyond that point will be noticed below. Outliers occur in Blenheim Park, at

* Geology of the Country round Woodstock, p. 22.

Dornford, and near Tadmarton, and a long inlier peeps up in the brook courses north of Bicester. The Forest Marble also comes to the surface at the centre of the dome-shaped inliers of Cornbrash at Wood Eaton, Oddington, and Blackthorn Hill.

"Owing to the rapid enclosure of Wychwood Forest many quarries have been opened in Forest Marble, of which we may mention those of Leafield, Waterman's Lodge, White Oak Green, and Minster Lovel; and the following succession may be clearly made out. The lower beds which rest on the white limestone of the Great Oolite, consist of shelly oolite, much false bedded, splitting into slabs and flags. They are composed principally of enormous quantities of broken oyster shells, with a smaller number of other shells, cemented by oolitic limestone. These beds are generally yellowish at the surface, but when reached at some depth are of the usual blue colour. They are quarried for wall stones and rough flags, and are about 30 feet thick. The higher beds consist of bluish clays and marls, with thin flagstones and roofing slates, for which they are quarried at White Oak Green. The surfaces of these flags are frequently marked with current ripples and worm tracts. Shells of *Ostrea, Pecten, Avicula,* fragmentary stems of *Pentacrinus,* and plates of *Echini* are not unfrequent. These beds vary from 20 to 30 feet in thickness.

"Towards Witney the Forest Marble becomes very thin, and is represented by a bed of clay resting on four or five feet of slaty oolite. These beds of clay are very inconstant. For example, we find the Cornbrash resting on a thick bed of Forest Marble clay in the railway cutting west of Hanborough station; but in the quarry at East End, North Leigh, we find Cornbrash resting on coarse shelly oolite of the Forest Marble, without any intervening clay bands, the distance between being about two miles.

"At Bladon there are good sections of the Great Oolite, Forest Marble, and Cornbrash, and the following may be observed at Bladon quarry:

		ft.	in.
Cornbrash.	Rubbly, evenly bedded, shelly limestone, with *Terebratula obovata, T. perovalis, Myacites.* -	2	0
Forest Marble.	Regularly bedded shales and sandy flags. -	6	0
	Hard bluish marly limestone, weathering white. -	1	0
	Bluish clay with *Ostrea.* - -	1	6
	Coarse shelly oolite, false bedded, quarried for slabs and building. - - - -	5	0
Great Oolite.	White limestone, seen in quarries and sections at Bladon.		

"In a quarry in Blenheim Park, opposite Old Woodstock, we find the following section:

		ft.	in.
Cornbrash.	Rubbly, shelly, cream-coloured limestone, in two beds, with a parting of marl; *Terebratula obovata, Avicula echinata, Myacites.* - -	5	0
Forest Marble.	Partings of marl and slate. - -	0	3
	Yellow, soft oolite, false bedded. - -	2	6
	Clays and flagstones, with broken shells, spines of *Echini,* stems of *Pentacrinus, Pecten vagans, P. fibrosus, Rhynchonella concinna.* - -	2	0
	Soft, white oolite, false bedded. - -	10	0

"Towards Tackley the Forest Marble becomes very thin, and above Enslow Bridge, on the west bank of the river, appears to have altogether died away. Here the Great Oolite reaches to the top of the cliff (see p. 17), and immediately above the Cornbrash may be observed in the road, so that there is actually no room for the Forest Marble. On the opposite side of the river, however, a thick bed of clay, from

which bricks are made, reappears, and from thence towards Stoney Middleton we always find underneath the clay five or six feet of shelly oolite and clayey bands, belonging to the Forest Marble."*

From hence this formation may still be traced to a point about three quarters of a mile north-west of Bucknell, when it is cut off by a fault bringing up the Great Oolite. The road from Bucknell to Ardley crosses a small outlier; the rock is a coarse, reddish brown, flaggy limestone, very much false bedded.

Beyond this point the Forest Marble seems to thin rapidly away, and traces of it have been found only in a few places. It nowhere reaches a thickness of more than three or four feet, and as it would have been impossible to trace so thin a bed over a drift-covered country, it has been left out on the map, except at those spots where sections prove it to be present. These few cases shall now be pointed out.

In a quarry by the brook-side, 58 chains east of Tingewick church, we have the following section :

		ft.	in.
Cornbrash.	Reddish-yellow, flaggy and rubbly limestone, *Avicula echinata.* - - - - -	5	0
Perhaps Forest Marble.	Brown sandy clay, full of broken shells. -	0	6
	White, marly clay, with smooth fracture, and evenly jointed. - - -	3	6
	Hard blue slaty limestone; surface of bed covered with oysters, spines of urchins, &c.		

The bottom bed has a very Forest Marble look ; the white clays are seen in most places where the junction of the Cornbrash and Great Oolite is laid open, but there are not confined to the horizon, being found in Cornbrash at Buckingham, and common throughout the whole of the Great Oolite. In the large quarry between Thornborough and Padbury (see p. 21) similar marly beds are found below the Cornbrash, but no other possible representative of the Forest Marble.

In the village of Thornton road cuttings and a large quarry close upon the edge of the map give the following section :

		ft.	ins.
Cornbrash.	Rubbly Cornbrash.		
Forest Marble.	Alternations of white, bluish, and brown clay, with beds of smooth, evenly jointed white marl; thickness seen in the quarry. - - - -	10	0
	Thin, flaggy, sandy limestone ; oysters, &c. -	2	0
Great Oolite.	Thick-bedded, white, shelly limestone. - -	3	0
	Thick-bedded, brownish limestone. -	3	0
	Thin-bedded, brown sandstone. -	2	6
	Thick-bedded, brownish limestone.	4	0

The white marly beds are of the same stamp as those just described; the thin bed of Forest Marble is very inconstant, and dies away altogether in places.

Once more the Forest Marble shows itself, cropping out on the west side of the hill below Leckhampstead farm, and in a quarry at Lillingston Lovell. Some deep drains at the first place cut through,

Cornbrash.	Rubbly Cornbrash, *Avicula echinata, Terebratula intermedia, Pecten vagans.*
	Pale, sandy clay.
Forest Marble.	Thin-bedded shelly grey limestone; fossil wood, oysters, spines of *Hemicidaris.*
Great Oolite.	Hard, white limestone; *Terebratula perovalis, T. ornithocephala.*
	Hard, thick-bedded, grey, shelly limestone ; *Lima cardiiformis, Ostrea Sowerbyi, Pecten annulatus, Rhynchonella concinna.*

* Geology of the Country round Woodstock, p. 23, 24.

The quarry gave the following section:

		ft.	in.
Forest Marble.	Grey, slaty limestone, current laminated. -	1	6
	Finely-laminated, brown clay, with thin plates of stone. - - -	1	4
	White marly clay, with smooth fracture, and evenly jointed. - - - - -	1	0
	Bluish clay. - - - - -	1	2
	Hard, grey, slaty limestone, almost entirely made up of oysters. - -	1	6
Great Oolite.	Hard white limestone. - - -	2	6

The boundary of the little outlier in which the quarry stands is everywhere hidden by Drift except on the west: the fault which has been drawn cutting off the Forest Marble to the south-west is seen in the road by Lillingston Lovell church; the beds there dip at the unusually high angle of 40°, and a strong spring breaks out a little lower down.

It will be noticed that in all these sections we have the same order of the beds as was observed by Mr. Hull on Wychwood Forest, clays in the upper part and slaty limestone below.

A little outlier of Forest Marble lies on the east of Tadmarton, near Banbury. It is let down into the Great Oolite by a fault, and consists of a few feet of hard, blue, flaggy limestone, almost entirely made up of oysters.

We also find this rock in the centre of the inliers at Islip, Oddington, and Blackthorn Hill; for sections see below, pp. 35, 36, 37.

Fossils from the Forest Marble at Islip and Kidlington. (Whiteaves.)

CŒLENTERATA.

Anabacia orbulites, Lam.

POLYZOA.

Cricopora straminea, Phil.

MOLLUSCA.

BRACHIOPODA.

Rhynchonella concinna, Sow.
Terebratula cardium, Lam.
„ „ var. *bifurcata*.

LAMELLIBRANCHIATA.

Ostrea Sowerbyi, L. & M.
O. acuminata, Sow.
Pecten rigidus, Sow.
P. annulatus, Sow.
P. lens, Sow.
P. arcuatus, Sow.
P. personatus, Goldf.
Placunopsis socialis, L. & M.
Gervillia acuta, Sow.
Pteroperna costatula, Desh.
Lima cardiiformis, L. & M.
L. duplicata, Sow.
Arca minuta, Sow.
Nucula variabilis, Sow.
Leda lachryma, Sow.
Limopsis oolitica, Sow.
Trigonia Moretoni, L. & M.
T. costata, Sow.
Cardium Stricklandi, L. & M.
Cypricardia rostrata, Sow.
Astarte interlineata, Lye.
A. minima, Phil.
A. n. sp.
Cyprina Loweana, L. & M.
Corbis, n. sp.
Tancredia truncata, Lye.
Corbula involuta, Goldf.
C. Macneillii, Morr.
C. n. sp.
C. n. sp.
Pholadomya acuticosta, Sow.

GASTEROPODA.

Cerethium quadricinctum, Goldf.
Ceritella acuta, L. & M.
C. longiscata, Buv.
Eulima communis, L. & M.
Rissoina duplicata, Sow.
R. lævis, Sow.
Nerita minuta, Sow.
N. Ibbetsoni, L. & M.
Trochus spiratus, D'Arch.
Crossostoma discoideum, L. & M.
Pagodus nodosa, L. & M.
Patella cingulata, Goldf.
Emarginula scalaris, Sow.
Cylindrites acutus, Sow.
Actæonina Luidii, Mor.

I learn from my colleague Mr. Tiddeman that well-preserved crustacean and molluscous tracks have lately been found by Professor Phillips and himself in the Forest Marble a little south of the railway station at Kirklington.

Cornbrash.

This formation, the highest member of the Lower Oolite, is in most places a group of limestones, of from 6 to 15 feet in thickness. Though so thin, it is regular in its bedding and very constant over the whole of the present country, contrasting in these points with the Forest Marble in the same way as the Upper Band of the Great Oolite contrasts with the Lower.

The limestones are either rubbly, or solid and thick bedded; the latter we often find in the lower part of the formation, with rubble above. In colour they are blue internally, but weather to a cream-colour or brown; each bit of the rubble has an outside coating of a deep reddish brown, and the ploughed fields, where this rock forms the subsoil, are of the same hue. There are also occasional thin beds of sandy marl from which fossils may be dislodged in a perfect state. Its marked mineral character makes the Cornbrash very easy to recognize, the pretty little shell *Avicula echinata*, which is typical of the formation, is also mostly present in it in great numbers.

The normal form of the Cornbrash is such as has been just described; we find however here and there clay beds which cause it to swell out to more than double its average thickness. These clays seem to be very irregular and never to run on for any great distance; they are mostly sandy and of a pale blue colour; but in one case, at Buckingham, there is a clay, belonging most likely to the Cornbrash, very stiff, and of all shades from black to light yellow.

The outcrop of the Cornbrash runs from Norton Brize by Witney, Woodstock, and Bicester to Buckingham, sometimes in a narrow belt along a hillside, but oftener the rock forms a very flat, broad plateau. There are besides the inliers, already mentioned, between Islip and Marsh Gibbon, and outliers on Whichwood Forest and at Combe, Maids Morton, and Leckhampstead.

Sections of this formation have already been given under the head of the Forest Marble. Besides these we have "several good sections "in quarries at Norton Brize, where the beds may be seen resting on "Forest Marble, which is worked for flagstones. There are frequent "sections in the roads round Witney. At Hanborough Station, and in "a quarry by the road to Bladon, the Cornbrash is very fossiliferous, "especially in *Terebratulæ*. There are several quarries between "Bladon and Woodstock Road station, the Cornbrash being here used "for road metal. There are also quarries by the road-side near "Sturdy's Castle. On the east side of the Cherwell valley, sections "may be seen in quarries at Kirklington Station, and on the south "side of Kirklington Park; also along the road to Middleton, south of "Slate Farm, where the rock is very full of fossils. Besides these "there are the quarries at Bladon and Blenheim Park, already "noticed."*

Over the broad plateau formed by the Cornbrash to the west and north of Bicester sections, all much alike, are plentiful about Middleton

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* Geol. of Country round Woodstock, p. 25.

Stoney, Chesterton, Caversfield, Bucknell, and Fringford. A quarry just outside Bicester on the road to Caversfield showed

	ft.	in.
Loose rubbly cornbrash, light yellow outside, bluish inside; sandy and incoherent at the bottom.	4	0
Hard blue shelly limestone, in two beds.	3	6

Below this came clay, which I was told had been bored into for 60 feet, but I had no means of testing the truth of this statement.

In the quarries at Stratton Audley are

	ft.	in.
Hard, yellow, rubbly limestone.	3	0
Rubbly limestone, mixed with sandy marl; yellow at top, blue towards the bottom.	4	0
Hard, solid, dark blue limestone.	2	6

Fossils were very plentiful. The order of the beds shown in these two sections is a very common one: at top rubbly beds, weakest in their lower part, and solid limestones below: it is again seen in a quarry above Tingewick Mill which shows

	ft.	in.	
Dirty blue clay, with a few pebbles.	2	6	Drift.
Brown clay.	2	0	
Flaggy limestone, unevenly bedded.	1	6	Cornbrash.
Loose rubbly limestone.	1	0	
Hard blue limestone.	3	0	

Between Fringford and Buckingham the Cornbrash is very much covered up with drift, and there are few sections. It is worked for road-making about half a mile south of Newton Purcell, and the railway cuts into it at Water Stratford and Radcliff, and in Buckingham Cemetery below the Drift Gravel they find

	ft.	in.
Rather hard, yellowish sandy limestone, with many fossils, *Avicula echinata*, *Serpula*, &c.	2	6
Hard, blue, solid limestone.	1	6

We next come to the remarkable section at Buckingham, already mentioned; it is given by a clay pit on the Bourton road, just out of the town, and is as follows:

	ft.	in.		ft.	in.
Drift Gravel.	5	0	to	10	0
1. Hard blue cornbrash limestone, full of fossils.	2	0		3	0
2. Sandy oyster bed.	0	4			
3. Dark, blue laminated clay.	0	4			
4. White, marly, chalk-like limestone, jointed, with *Cypris* or *Estheria*, *Naticopsis*, *Unicardium*, *Astarte*.	1	0			
5. Hard, yellowish, sandy limestone.	1	0			
6. Stiff blue clay, with broken shells, lignite, pyrites.	5	6			
7. Very stiff, dark black, clay.	4	0			
8. Blue and yellow mottled clay.	3	0			

White limestone, most likely Great Oolite, was reached a little lower down.

No. 4 is very like the marly limestones which have been already mentioned as occurring at the junction of the Forest Marble and Great Oolite, but unlike them it is crowded with fossils. My colleague, Mr. Polwhele, was inclined to look upon the stiff clays, Nos. 6, 7, 8, as belonging to the Forest Marble; but as none of the flaggy limestones typical of that formation were seen, and as the traces of Forest Marble

in the neighbourhood were so few and so very doubtful, Prof. Ramsay thought it safer to place the whole in the Cornbrash. On this view the section is very exceptional, as elsewhere the Cornbrash clays are sandy and of a pale blue colour. The upper surface of No. 1, on which the gravel rested, was much weathered and waterworn into hollows and little pot holes.

Two quarries near Buckingham show an unusual thickness of solid Cornbrash limestones without any of the rubbly beds: the one on the Stony Stratford road gives the following section:

		ft.	in.
	Coarse, dirty gravel.	18	0
Cornbrash.	Hard, blue, shelly limestone, many fossils.	3	4
	Brown sandy clay.	0	6
	White, sandy limestone, with corals, *Stylina*, *Thamnastræa arachnoides*, &c. 9 in. to	1	6
	Brown clay with lignite.	0	9
	Hard, brown, sandy, oolitic limestone.	3	0
Gt. Oolite.	Hard white limestone in two beds.		

Again on the Bourton road, three-quarters of a mile from the town, we have

	ft.	in.
Soil.	1	0
Gravel.	2	0
Flaggy limestone.	1	0
Hard, blue limestone.	2	3
Hard, light buff, limestone.	2	0
Rubbly marl.	2	0
Limestone (full thickness not seen).	4	0
Clay, with lignite.		

Cornbrash has been largely quarried in the valley of the Thornborough brook, and we have there, in two brick pits about half-way between Padbury and Thornborough, good sections of the clays of this formation. At one we find

	ft.	in.
Trace of drift gravel.		
Light blue clay.	3	0
Bedded, clayey sand, mottled red and light blue; *Terebratula intermedia*.	6	0
Dark blue clay, *Cidaris* and broken *oysters*.		

The clay was more or less sandy throughout; it contained septaria, selenite, pyrites, and besides the fossils mentioned above *Avicula echinata*, *Myacites recurva*, and many oysters: it was said by the workmen to be about 20 feet thick, and to rest on rock, most likely the bed of Cornbrash limestone which shows at the top of the large quarry on the opposite side of the road.

Like beds have been worked for brickmaking at Buckingham, on the road to Gawcott. I was told by a workman that they found there

	ft.	in.
Gravel and loam.	9	0
Light blue clay.	5	0
White limestone (probably Great Oolite).		

A bed of the clay has also been worked at Thornton; it was found to be from 15 to 20 feet thick, but it thins away altogether in about 200 yards from the Brick Pit.

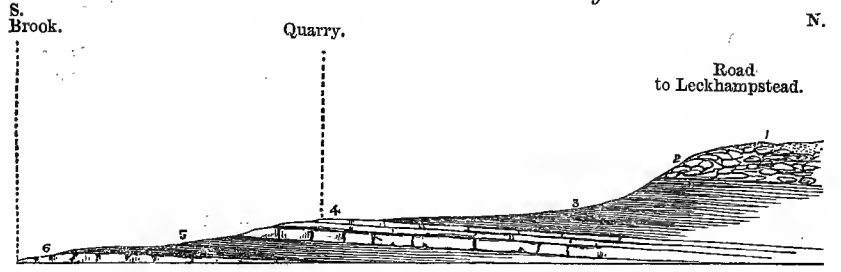
Lastly we give sections in and about Thornborough, which seem

to show a thickness of 40 feet or more of Cornbrash limestones and clays.

		ft.	in.	
2.	Yellow, rubbly limestone. } Seen on the road from Thornborough			
3.	Blue clay, rather sandy. } to Leckhampstead.			
4.	Yellow, rubbly limestone.	1	6	Quarry in Thornborough.
	Sandy clay. - -	0	6	
	Solid limestone, blue inside, yellow outside.	1	0	
	Rubbly and sandy limestone.	1	0	
	Solid blue limestone, in two beds. - -	2	4	
5.	Clay.			
6.	Solid limestone.			In bed of brook at Thornborough.

The sketch below shows the position of these beds.

Fig. 6.—*Section near Thornborough.*

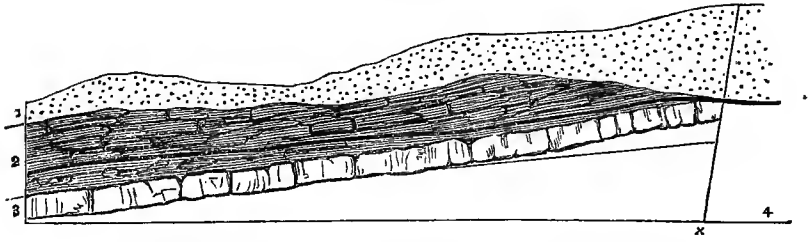


1. Drift.
2. Rubbly limestone.
3. Sandy clay.
4. Limestone.
5. Clay.
6. Limestone.

The lower boundary of the Cornbrash is much hidden by Drift in the N.E. quarter of the sheet. We will now give shortly the evidence from which the line has been drawn.

About Beanton the boundaries on the N. and W. are faults: the first of these is seen in the section below given by a lane, a quarter of a mile W. of Beanton: beyond this the sudden change of soil in the

Fig. 7.



1. Debris and soil.
2. Yellow rubbly limestone.
3. Hard blue shelly limestone. (*Avicula echinata.*) } Cornbrash.
4. White limestones and marls of the Great Oolite.

Black line. Level of the road.

× Fault.

ploughed fields gives its line very closely. Good evidence for the other fault, running north, is given by the relative levels of Cornbrash and Great Oolite about Beanton; this fault has been supposed to throw down a little patch of Cornbrash, which is found in a most unlooked-

for place at the bottom of the valley by Hethe Braid; and for want of better evidence the fault has been made the western boundary of the formation at Hardwick.

From here to the Buckingham and Banbury railway the ground is thickly covered with Drift gravel, and the boundary-line wholly conjectural, except about Hethe, where we get a fair approximation (see section on p. 18). This debateable ground passed, the line runs along the south bank of the Ouse, mostly below the level of the drift, and is accordingly traced with more ease and certainty. Its position can be fixed very closely at the railway cutting at Water Stratford, at Tingewick Mill, by a quarry 58 chains E. of Tingewick church (see p. 28), and hence onwards to Buckingham and Bourton. The junction then becomes hidden round the hill on which White House stands, but it is well given along the valley of the Thornborough Brook, on the road from Thornborough to Leckhampstead (p. 21) and in the village of Thornton, close to the eastern edge of the map (p. 28).

It remains to notice two outliers of Cornbrash on the north of Buckingham, one lying on the high ground round Maids Moreton, and the other capping the ridge on the east of the Leckhampstead valley.

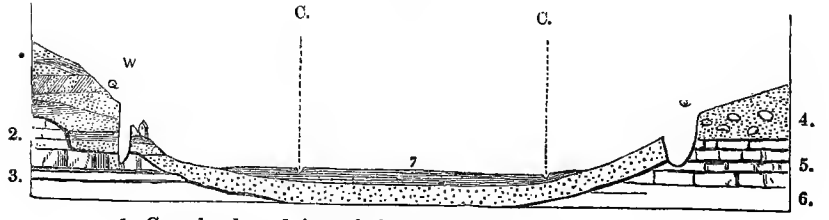
At the S.W. corner of the first of these we find Cornbrash clay in the section given below, on the railway, $15\frac{1}{2}$ miles from Banbury. There

Fig. 8.

1. Gravel. 2. Light-blue sandy clay.

are sections in Great Oolite beds a little lower down, in the village. Between here and Buckingham there are several sections which give the boundary very closely. Behind Buckingham workhouse about 40 feet of sand and gravel rests on Great Oolite limestone, while the quarry on the Stony Stratford road, already mentioned, shows Cornbrash lying on the same bed. The section below gives the most likely explanation of this.

Fig. 9.*



1. Gravel and sand, irregularly bedded.
2. Probable position of Cornbrash.
3. Great Oolite.
4. Very coarse gravel, faint traces of bedding.
5. Cornbrash.
6. Great Oolite.
7. Alluvium.

Q. Quarries. C. Canal. W. Workhouse.

* Figs. 8 and 9 both show well the existence of a valley in the stratified rocks previous to the deposition of the drift. This has been filled up with gravel and then partly hollowed out again.

Beyond this point we get evidence for the boundary south of Foxcott, at South End and N.E. of Akeley, but the remainder of the line is wholly conjectural. All that can be said in its favour is that the Cornbrash must end on the north before Lillingston Dayrell, and on the west before Boycott, for about both these places sections in Great Oolite are plentiful, but how far the rock runs in these directions we cannot exactly say.

Very much the same may be said of the boundaries of the Cornbrash on the hill E. of Leckhampstead valley; on the N.E., E., and S.E. they are wholly conjectural, while the sections already described at Leckhampstead Farm and some few to the south fix the lines thereabouts very closely.

The ground on which these two outliers lie is high enough to leave room for a capping of Oxford Clay. No sections, however, were obtained to prove the presence of this formation, and all the evidence seemed to show that the drift was quite thick enough to make up that part of the hill which lay above the outcrop of the Cornbrash. The ground has been therefore coloured as Cornbrash all over, but it must not be forgotten that patches of Oxford Clay may lie upon the hill tops beneath the drift covering.

The Cornbrash again comes out to day in a number of inliers along an anticlinal line ranging from Islip to Marsh Gibbon; and these shall now be described.

Islip.—This is a large, flat-topped boss, rising sharply from the Oxford Clay plain.

The section below was measured by Mr. Whitaker in a quarry, about a quarter of a mile north of the village:

	ft.	in.		ft.	in.
1. Flaggy limestone, worn away in most parts. - -	0	6	to	0	8
2. Greenish, marly clay, passing into - - -	1	0			
3. Bluish-black clay. - - -	0	6			
4. Very pale, calcareous clay, passing into -					
5. Light-coloured, friable limestone, with fossils, passing into - - - -	1	0			
6. Bluish, shaly clay, with *Ostreæ* and other small fossils and grains of limestone; brown at the bottom. -	0	6			
7. Flaggy oolitic limestone, with *Ostreæ* and broken shells. - - - - -	1	3	to	1	6
8. Limestone with a little clay. *Terebratula maxillata.*	0	6			
9. Blocky oolitic limestone. - - - -	6	0			

Of these beds No. 1 is most likely Cornbrash, 2 to 7 Forest Marble, 8 and 9 Great Oolite. The beds are somewhat domed.

To the south-west of the Station is a deep cutting, now a good deal fallen in; the following is about the order of the beds:

		ft.	in.
Cornbrash.	Rubbly Cornbrash limestone. - - -	3	0
Forest Marble.	Laminated white and blue clay passing into pale blue clay. - - - - -	8	0
	Hard, grey, oolitic limestone. - -	4	0
	Fine flaggy, brown oolite. - - -		
	Clay, about - - - - -	2	6
Great Oolite.	White limestone, *Nerinæa* or *Chemnitzia.*		

There is a dip of 5° to the S.W. The beds must however roll over before the station or there must be a small fault.

At the south end of the village, after crossing the river, we find in a quarry the section below:

		ft.	in.
Cornbrash.	Yellow rubbly limestone.	2	0
Forest Marble.	Pale blue clay.	0	6
	Flaggy Forest Marble.	0	6
	Pale blue clay.	2	0
Great Oolite.	White marl.	1	0
	Solid white limestone with partings of white marl (*Lima Cardiiformis*).		

The beds dip to the north at about 5°, but roll over and flatten southwards.

Forest Marble reaches the surface in the middle of this inlier; it may be seen in several quarries by the turnpike road.

Charlton and Oddington.—These two villages stand on a long narrow ridge, but little raised above the plain of Oxford Clay, formed of Cornbrash limestone with the Forest Marble peeping through in two little patches. A quarry in one of these west of Oddington church showed

		ft.	in.
Forest Marble.	Flaggy Forest Marble, oolitic, full of broken shells.	1	0
	Sandy clay and rubble.	1	0
	Flaggy Forest Marble, oolitic, full of oysters and broken shells.	1	3
	Pale blue clay, weathering brown.	3	0
Great Oolite.	White clay, mixed with limestone rubble.	1	0
	Solid whitish limestone, very oolitic.		

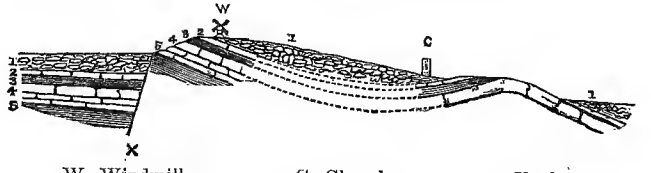
Cornbrash quarries may be seen by the roadside between the two villages, and Forest Marble again crops up in the street at Charlton, the dome-shaped bedding being well shown by the dips seen there. Further to the north-east by the windmill we have quarries and a brick pit giving the section below:

	ft.	in.
1. Rubbly Cornbrash limestone.	2	0
2. Flaggy Forest Marble, oolitic.	0	6
3. Yellowish marl.	0	3
4. Solid whitish oolitic limestone.	3	0
5. Pale blue clay.		

There is a small fault bringing the clay against the Cornbrash; this and the general run of the beds is shown in the diagram below, the numbers on which refer to the section just given.

Fig. 9a.

Diagram Section through Charlton.



W. Windmill. C. Church. × Fault.

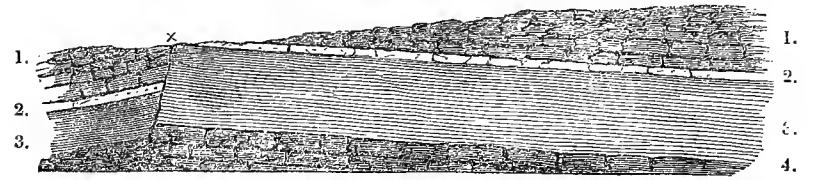
We next find Cornbrash at Merton forming a low, flat-topped hill, rising very gently from the plain. There is a quarry on the north-east of the village.

Blackthorn Hill.—This after Islip is the largest and best marked of the line of inliers. It is a long, oval-shaped, heavy-looking dome, rising to a height of about 40 feet above the Oxford Clay round it.

Cornbrash limestone may be seen in several quarries; the best section, of which a sketch is given below, being at the Brick-kilns on the top of the hill.

Fig. 9b.

Section at the Brick-kiln, Blackthorn Hill.



	ft.	in.
1. Cornbrash, weathering into rubble at the surface, solid below.	4	0
2. Nodular, white, marly limestone.	0	9
3. Light-blue, laminated clay.	7	0
4. Blue, flaggy Forest Marble.	4	9
× Fault.		

Below this I was told came a little clay, and then a white stone, most likely the top bed of the Great Oolite. The bed marked No. 2 agrees exactly with the white, marly limestones, so often found at the base of the Cornbrash about Buckingham (see p. 28, 29).

A quarry a little way south of the "H" in the word Hill shows well the dome-shaped bedding of this inlier; in the lower part the beds have a dip of 2° or 3° to the S.E., and as we climb the hill gradually flatten, the slope of the ground coinciding very nearly with the inclination of the beds, as is no doubt very generally the case hereabouts.

The next inlier, at West Stan Hill, is a very low hummock; a quarry about the middle showed loose, rubbly, Cornbrash with a bed of pale blue clay full of oysters.

The Cornbrash has been again laid bare along this line by the denudation of the Oxford Clay at Marsh Gibbon. The village stands on a low hill of the former rock, and to the north of it is a little plateau from which hills of Oxford Clay rise on the west, north, and east. The rock has been largely quarried on this plateau, and is rich in fossils. The general order of the beds seemed to be:

Loose rubbly Cornbrash.
Soft marly clay, mixed with rubble.
Hard blue limestone.

It is worth noticing how each of these little inliers, which lie like islands in the midst of the inhospitable swamp of Oxford Clay, has been seized upon for the site of one or more villages. West Stan Hill is the only exception, and this is doubtless owing to its being too low to strike the eye.

The saddle, along which these Cornbrash patches lie, cannot I am told by Prof. Phillips be traced beyond Islip on the south-west; along the line produced to the north-east, however, we find, wherever it crosses a part of the country not hidden by drift, signs of disturbance for a long distance. It runs by the large quarry between Thornborough and Padbury, where we have seen that the beds are faulted (see p. 21).

We next get a section on this line in a brook course near Bradwell (in Map 46 N.W.), and here the beds are much broken. Then follows a broad tract of drift-covered country, beyond which we again find a small fault, running nearly along the line, near Milton Ernest, on the edge of Map 52 S.W. ; and here we must at present leave it, till the Survey work has been carried further into the country to the east.

Fossils from the Cornbrash at Islip and Kidlington. (Whiteaves.)

ANNULOSA.

Echinodermata.

Cidaris Bradfordensis, Wright.
Pedina Smithii, Forbes.
Acrosalenia hemicidaroides, Wright.
A. spinosa, Ag.
Stomechinus intermedius, Ag.
Holectypus depressus, Leske.
Clypeus plotti, Klein.
Pygurus Michelini, Cotteau.

CŒLENTERATA.

Anabacia orbulites, Lamk.

Polyzoa.

Alecto dichotoma, Lamk.
Diastopora diluviana, Milne Edw.
Cricopora straminea, Phil.

MOLLUSCA.

Brachiopoda.

Rhynchonella morieri, Dav.
R. concinna, Sow.
Terebratella hæmisphærica, Sow.
Terebratula cardium, Lamk.
T. intermedia, Sow.
T. obovata, Sow.

Lamellibranchiata.

Ostrœa Sowerbyi, L. & M.
O. acuminata, Sow.
O. costata, Sow.
Placunopsis socialis, L. & M.
Pecten vagans, Sow.
P. hemicostatus, L. & M.
P. arcuatus, Sow.
P. lens, Sow.
P. annulatus, Sow.
P. personatus, Goldf.
Gervillia acuta, Sow.
G. ovata, Sow.
G. n. sp.
Lima duplicata, Sow.
L. gibbosa, Sow.
L. cardiiformis, Sow.
L. impressa, L. & M.
Mytilus sublævis, Sow.
Modiola Sowerbyana, Bronn.
M. compressa, Portlock.
M. aspera, Sow.
M. imbricata, Sow.
Lithodomus inclusus, Phil.
Macrodon Hirsonensis, D'Arch.
Arca æmula, Phil.
Nucula Menkii, Rœmer.
N. variabilis, Sow.
Leda mucronata, Sow.
L. lachryma, Sow.
Trigonia Moretoni, L. & M.
T. costata, Sow.
T. Goldfussii, Ag.
Cardium Buckmannii, L. & M.
C. Stricklandi, L. & M.
C. subtrigonum, L. & M.
Cypricardia rostrata, Sow.
Cyprina Loweana, L. & M.
Isocardia minima, Sow.
Corbula involuta, Goldf.
C. Macneilii, Mor.
C.
Pholadomya deltoidea, Sow.
Myacites gibbosus, Sow.
M. decurtata, Phil.
M. securiformis, Phil.
Gresslya peregrina, Phil.

Gasteropoda.

Patella cingulata, Goldf.
Monodonta.
Chemnitzia variabilis, L. & M.
Actæonina Luidii, Mor.

FOSSILS from the CORNBRASH.—From Collections made by the Survey.

FOSSILS.	Witney.	Woodstock.	Norton Brize.	Sturdy's Castle.	Buckingham.	Blackthorn Mill.
CŒLENTERATA.						
Thamnastræa arachnoides, M. Edw.					×	
Cyathophora Prattii, M. Edw.					×	
ANNULOSA.						
ECHINODERMATA.						
Nucleolites Plottii, Klein	×					
N. clunicularis		×		×		
Acrosalenia Wiltoni, Wright	×					
MOLLUSCA.						
BRACHIOPODA.						
Terebratula intermedia, Sow.		×			×	×
T. maxillata, Sow.		×				
T. ornithocephala, Sow.			×		×	
T. obovata, Sow.		×		×		×
Rhynchonella concinna, Sow.	×				×	
LAMELLIBRANCHIATA.						
Pecten vagans, Sow.	×		×	×		
P. demissus, Phil.	×				×	
P. fibrosus, Sow.	×					
Lima rigidula, Phil.	×					
L. interstincta, Phil.	×				×	
L. duplicata, Sow.					×	
Ostrea gregaria, Sow.			×			
Avicula echinata, Sow.	×	×	×	×	×	
Pholadomya deltoidea, Sow.	×	×		×		
Myacites decurtata, Goldf.	×	×	×	×		
M. securiformis, Phil.		×			×	
M. calceiformis, Phil.		×			×	
Trigonia striata, Sow.		×				
T. costata, Sow.	×	×	×			
Astarte aliena, Phil.		×			×	
A. depressa, Goldf.					×	
Modiola cuneata, Sow.	×					
Arca	×				×	
Unicardium	×				×	
CEPHALOPODA.						
Ammonites macrocephalus, Schlott	×					
A. discus, Sow.	×					

CHAPTER IV.

MIDDLE OOLITES.

Clunch or Oxford Clay.

Above the Cornbrash comes a thick mass of pale-blue clay or shale, weathering yellow at the surface, with here and there thin beds or nodules of earthy limestone, the Clunch Clay of Smith or Oxford Clay of other authors. In the lower part of this formation there are occasionally some beds of tough calcareous sandstone, with brown sands, called the Kelloway Rock: no traces of this bed are found in the present district. Near Kirtlington however Prof. Phillips finds, about the horizon of the Kelloway Rock, Ammonites Kœnigii, a fossil characteristic of this bed both in Wiltshire and Yorkshire.*

The Oxford Clay covers a broad belt of country to the south-east of a line through Witney, Bicester, and Buckingham; a few outliers occur on Whichwood Forest, one at Combe, and one at Akeley north of Buckingham.

Nearly the whole of this country is thickly covered with Drift and sections are very scarce. "The outliers at Leafield and Ramsden "Heath are capped by high level quartzose gravel, and reach an "elevation of about 500 feet. From these points, commanding a wide "range of country, the distant escarpment of the Coral Rag and Chalk "may be distinctly traced for many miles. At Leafield, in sinking a "well, crystals of selenite were found. Oxford Clay may be observed in "some old pits on Hailey Common, but it is much mixed with Drift "gravel and sand. The next section is that near High Lodge, in "Blenheim Park, where the clay is used for bricks and tiles, but though "well searched no fossils were found. At Tackley Heath the clay "appears to have been used for a similar purpose; as also on the "north side of Kirklington Park."*

Between Oxford and Bicester we have the dreary flat of Ot Moor formed of this clay, and beyond that a country slightly raised into heavy looking hills. I saw no sections, but the clay is constantly being turned up in ditches and drain cuttings. The characteristic fossil *Gryphæa dilatata* may be often found in these excavations.

A brick pit on the Bicester and Buckingham road, $3\frac{1}{2}$ miles from Bicester, showed light-blue shaly clay, yellowish at top, with much selenite: about a quarter of a mile to the south of this a well was sunk for 50 feet into the clay without reaching the bottom. Oxford Clay may be seen in the two railway cuttings to the S.E. of Buckingham station, and we have a good section in a brick pit near Padbury Mill, here the clay was shaly and of a dark blue colour, with large nodules and septaria of limestone. The nodules yielded *Ammonites Callovicensis*, *Belemnites*, and *Gryphæa dilatata*, and the clay the latter shell and *Ammonites Jason*. A bed of limestone nodules, perhaps the same as that just mentioned, shows in the railway cutting half a mile to the south of the brick pit; among other fossils it contained *Cardium cognatum* and a *Pecten*. About $1\frac{1}{4}$ miles S. 20° E. from Goddington church some drain cuttings went through a bed or beds of

* Quarterly Journal of Geol. Soc. vol. xvi. p. 117.
† Geol. of the Country round Woodstock, p. 26.

hard, cream-coloured, calcareous clay, slightly concretionary, and very full of fossils, few in species but abundant individually: the following have been determined by Mr. Etheridge, and are given below.

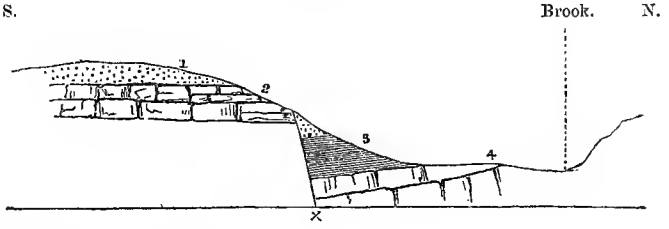
FOSSILS from the OXFORD CLAY of GODDINGTON.

MOLLUSCA.

LAMELLIBRANCHIATA.	CEPHALOPODA.
Avicula ovalis, Phil.	*Ammonites Jason*, Rein.
Inoceramus.	,, *Elizabethiæ*, Pratt.
Lucina.	,, *cordatus*, Sow.
Astarte carinata, Phil.	

A small outlier of the formation is found to the north of Akeley which seems to have been let down into the Cornbrash by a fault. It is seen in a brick pit, three-eighths of a mile from Akeley on the road to Lillingston Lovell. The ground is much covered with Drift, and we can only make a rough guess how things lie, but the section below is probably not far from the truth. The greatest thickness of clay proved was about 25 feet. A fine specimen of *Ammonites Kœnigii* was found in the pit.

Fig. 10.



1. Drift.
2. Cornbrash, seen by roadside.
3. Brick pit in Oxford Clay.
4. Cornbrash Quarry, many fossils, *Avicula echinata, Terebratula intermedia*, &c.

× Fault.

"The Oxford Clay has been penetrated at Oxford and Wytham to a depth of 265 feet and 596 feet respectively."*

As was the case with the Cornbrash, the lower boundary of the Oxford Clay is much hidden by Drift in the N.E. quarter of the map. Between Fringford and the railway cutting south of Buckingham both Oxford Clay and Cornbrash are thickly covered by Drift, and the only section that is of any use in drawing the line between them is a quarry half a mile S.E. of Tingewick, where blue sandy Cornbrash limestone was reached below Drift. The evidence in favour of the line as drawn on the map is, (1) a well marked table of country supposed to be formed of Oxford Clay, which rises with a short but steep step from a plateau on which Cornbrash may be seen in spots, and which is mostly likely wholly covered by that rock: (2) the fact that over the table land the Drift is clayey and over the plateau sandy and gravelly, pointing to clay below the first and rock below the second. The railway cuttings at Buckingham and the Padbury brick pit give us a rough notion of the line between these places. Between Padbury and the eastern edge of the map an abrupt and almost unbroken ridge which rises from the undulating ground between Padbury and Thornborough, known to be occupied by Cornbrash, has been taken for the escarpment of the Oxford Clay.

* Geol. of Country round Woodstock, p. 26.

Fossils from the Oxford Clay.—Survey Collections.

Fossils.	Between Ixhill and Catsbrains.	Quainton.	Ludgarshall.	Claydon.
PLANTÆ.				
Wood ?		×		
ANNULOSA.				
Echinodermata.				
Ophiocoma		×		
Cidaris florigemma spine, Phil.		×		
Annelida.				
Serpula				
Crustacea.				
Astacus		×		
MOLLUSCA.				
Brachiopoda.				
Rhynchonella		×		
Lamellibranchiata.				
Ostrea sandalina, Goldf.	×			
O. acuminata, Sby.		×		
O. sp.		×		
Gryphæa dilatata, Sby.	×	×	×	
G. sp.		×		
Pecten fibrosus, Sby.		×		
Nucula elliptica, Phil.		×		
Avicula		×	×	
Astarte		×		
Pinna mitis, Phil.		×		
Arca		×	×	
Trigonia costata, Park		×		
T. clavellata, Park		×		
Gasteropoda.				
Rostellaria		×		
Cephalopoda.				
Belemnites hastatus, Blainv.		×	×	
B. abbreviatus, Miller				×
B. sp.			×	
Ammonites cordatus, Sby.			×	
A. biplex, Sby.				×
A. canaliculatus, D'Orb.		×		
A. Duncani, Sby.		×	×	

Coralline Oolite.

Two members of this group are found in our district, the Lower Calcareous Grit and the Coral Rag.

Lower Calcareous Grit.—This formation consists on Wytham Hill and between Headington and Stanton St. John of yellow sands here and there cemented by carbonate of lime into calcareous sandstones and grits. It is very changeable in character.

Coral Rag.—The typical form of the Coral Rag is a yellow, crumbly, sandy limestone, almost entirely made up broken shells, corals, sea urchins, and other animal remains, with here and there large reef-like masses of coral. Beds of more solid blue limestone are also found. The following section taken in a quarry on the road from Oxford to Shotover Hill will give a fair general notion of this formation.

		ft.	in.
Coral Rag.	Loose, rubbly, grey limestone, weathering yellow, full of broken shells, corals, plates and spines of urchins. -	6	0
	Brown clay full of broken shells. - - - -	0	6
	Hard, solid, grey limestone, oolitic; in two beds: crowded with broken shells: a few small pebbles of Lydian stone.	3	4
Calc. Grit.	Soft yellow sand. - - - - - -	6	0

The Coralline Oolite is found on Wytham Hill, about the villages of Headington, Elsfield, Beckley, and Stanton St. John, and seems to be represented by a band of clay containing *Ostrea sandalina*, which has been traced between the Oxford and Kimeridge Clay up to the base of Quainton Hill.

Wytham Hill.—"The Lower Calcareous Grit may be observed cropping out along the north flank of the escarpment below the Coral Rag, and also along the narrow neck which divides the two areas of this latter formation. A second outlier occupies a small knowl south-east of Swinford Bridge, and is capped apparently by a few square yards of Coral Rag. In this place the Calcareous Grit appears to have lost considerably in thickness.

"The Coral Rag caps the hill in two detached areas. On the more southerly area there are few sections, as the formation is covered by a thick bed of high-level gravel; but on the northerly portion above Wytham Wood there are some old quarries and road sections. The beds consist of unevenly bedded fossiliferous limestone or ragstone, composed principally of corals, shells of *Mollusca* and *Echinodermata*, generally in a fragmentary state. The thickness of the beds is here considerable, but often appears greater than the reality. The following fossils have been collected from these strata:—*Lithodomus inclusus*, *Lima rudis*, *Ostrea gregaria*, *Thecosmilia annularis?* *Isastræa oblonga*. Spines and plates of *Cidaris* and portions of *Serpulæ* are common everywhere."*

This formation again runs into our district about the villages of Headington, Elsfield, Beckley, and Stanton St. John, and forms a low table-land, with a gentle slope towards the south.

Over the greater part of this patch the Calcareous Grit is a soft yellowish-brown sand, here and there cemented by carbonate of lime into irregular layers of hard stone. The sand has been largely worked between Elsfield and Beckley, and may be seen elsewhere in ditches and natural sections. "At Stow Lodge, three miles north of Headington, there is a stone pit, showing alternations of light-coloured sand and limestone, some of the former with thin layers of clay."† One mile E.S.E. of Beckley church we find at the base of the formation a hard lime-cemented sandstone, with a thin band of clay in the middle of it. At the south-east end of

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* Geology of the Country round Woodstock, pp. 26, 27.

† From the Note-book of Mr. Whitaker.

the village of Stanton St. John a large quarry gives the section below:

		ft.	in.
Coral Rag.	1. Yellow rubbly limestone full of broken fossils. -	3	0
Calc. Grit.	2. Yellow and brown sandy clay with irregular beds of concretionary limestone, full of broken shells, *Ostrea sandalina*, &c. - -	10	0
	3. Hard, dark-blue limestone. - -	6	0

Hence by Breach Farm the Calcareous Grit takes a stony form, showing as a hard sandstone with a calcareous cement, like the bed at Studely described below.

The Coral Rag is found in several outliers, and has the general character described above. It may be seen at Forest Hill; in large quarries between Woodperry House and New Inn; on the west of Stow Wood, where it is tilted by a fault; and in the large quarries at Headington, just beyond the southern edge of the map, where the topmost bed is a freestone, not seen elsewhere hereabouts in this formation.*

Evidence of the fault running across this patch is found at Forest Hill, where we have the limestone of the Coral Rag at a higher level than the Lower Green Sand hard by; on the road from Headington to Beckley, where the sand of the Calcareous Grit is brought against Coral Rag, the former occupying rather higher ground than the latter; and on the west of Stow Wood, where the Coral Rag is seen tilted and shattered.

There now remains the somewhat questionable continuation of this formation, under the form of a clay, through Worminghall, Boarstall, round Muswell Hill, and through Dorton to the base of Quainton Hill. About this line I can only give a few observations of my own, made during a visit after the publication of the map, the lines of which had been laid down by my former colleague Mr. Polwhele.

At Studley is "a peculiar bed of clouded grey colour, and very "tough and dense texture, a sort of argillaceous chert, rich in *Pinnæ*, "*Ammonites*, and other organic remains."† This bed runs with a good escarpment by Arngrove Farm to the north of Gravel Pit Farm, beyond which point we lose sight of it altogether. It dips gently to the east, but whether it runs under the clay beds to the east of it, or passes into a clay, it is not easy to say. Immediately below this stone we find Oxford Clay with *Gryphæa dilatata*, and it is therefore without doubt the bottom bed of the Calcareous Grit.

To the east of this is a band of very marked light-blue clay, somewhat sandy, and in many places crowded with *Ostrea sandalina*. This bed ranges through Worminghall, Oakley, and Boarstall, and was again found with its characteristic fossil at Westcot, and one mile west of Waddesdon Field. On the strength of this evidence a belt of this clay has been drawn between the Kimeridge and Oxford Clays up to the last-named spot, from whence it has been supposed to thin away towards the north-east, and it has been looked upon as the representative of the Coralline Oolite, (1) from its position, lying as it does between the Oxford and Kimeridge Clays, and differing in mineral character from both; (2) from the abundance of *Ostrea sandalina* found in it, that shell being plentiful in the lower part of the Coral Rag.

The section at Stanton St. John, given on page 44, may possibly be some guide in further unravelling the obscurities of this district. The grit of Studely may be equivalent of No. 3 in that section, become more earthy; and the clay of Boarstall may overlie this grit, and represent No. 2. Further to the north-east the Studely grit may die out, and the

* See Memoir of Geol. Survey on Sheet 13, p. 8.
† Phillips, Manual of Geology, p. 307.

clay bed be all that is left of this formation; while still further on this last representative may fail, and the Coralline Oolite thin away altogether.

Mr. H. Seeley, in a paper in the tenth volume of the third series of the Annals and Magazine of Natural History, describes a clay called by him the Tetworth Clay, which he regards as "the argillaceous con-" temporary of the Oxford Oolite" in Huntingdonshire; and it may be that this is the equivalent of the clay of Wormingball and Boarstall.

FOSSILS from the CORAL RAG and CALCAREOUS GRIT.—From the Survey Collections.

FOSSILS.	Oakley.	Catsbrains.	Arngrove Farm.	Wormingball.	Ludgarshall.	Ickford.	Westcot.
ANNULOSA.							
ECHINODERMATA.							
Pentacrinus -				×			
ANNELIDA.							
Serpula, sp. - -			×	×		×	×
CRUSTACEA.							
Glyphæa - - -					×		
MOLLUSCA.							
BRACHIOPODA.							
Rhynchonella varians, Shloth. - -					×		
LAMELLIBRANCHIATA.							
Ostrea Sandalina, Goldf. -	×			×	×	×	×
O. sp. - - - -				×			×
O. gregaria, Sow. - -							×
Gryphæa dilatata, Sow.		×		×	×	×	×
G. sp. - -						×	
Avicula inæquivalvis, Sow. - -			×				
A. sp. - -				×			
Pecten fibrosus, Sow. -			×				
Pholadomya æqualis, Sow. -			×				
P. sp. - - -			×				
Arca quadrisulcata, Sow. -			×				
A. sp. -			×		×		
Modiola bipartita, Sow. -			×				
Thracia or *Anatina* - -			×				
Pinna quadrata, (*Inoceramus* ?) -			×				
P. lanceolata, Sow. -			×		×		
Myacites -			×				
Nucula - - -					×		
GASTEROPODA.							
Pleurotomaria reticulata, Sow.					×		
CEPHALOPODA.							
Belemnites abbreviatus, Mill. -				×	×	×	×
B. sp. -				×	×		
Ammonites cordatus, Sow.			×	×	×		
A. vertebralis, Sow. - - - -			×				
A. Lamberti, Sow. - -				×	×	×	
A. Mariæ, D'Orb. -					×		
A. biplex, Sow. - -						×	
A. sp. - - -					×		

CHAPTER V.

UPPER OOLITES.

Kimeridge Clay.

This is a dark blue, very stiff, shaly clay, with thin beds and nodules of earthy limestone.

It is found over a belt of country studded over with outliers of Portland Beds, in the south-eastern part of the district.

There are no good sections in the country now under consideration, but the formation is beautifully laid open in plenty of brick-pits about Headington quarries, just beyond the southern edge of the map. From sections on the north-west of Shotover Hill I estimated its thickness at about 40 feet, but Professor Phillips tells me that it sometimes reaches double that amount. About 13 feet from the bottom a layer of nodular earthy limestone may be seen in one of the brick-pits, and great quantities of selenite are often found in the clay.

In the country about Aylesbury we get better sections of the Kimeridge Clay, and abundance of fossils; these will be described in a memoir on Sheet 46.

A. H. Green.

Fossils from the Kimeridge Clay, N.W. side of Brill.—From the Survey Collections.

Crustacea.

Astacus.

Brachiopoda.

Lingula ovalis, Sby.

Lamellibranchiata.

Ostrea.
Pecten.
Avicula.
Pinna granulata, Sby.
Pinna, sp.
Cardium striatulum, Sby.
Arca.
Astarte Hartwelliensis, Sby.
Thracia.

Cephalopoda.

Ammonites biplex, Sby.

Portland Beds.*

This formation is generally divided into two parts, the upper calcareous, the lower sandy. In this district however the division between the pale cream-coloured Portland Limestone and the light buff Portland Sand is not always well marked, as there are often beds of limestone in the latter. This my colleague Mr. Green finds to be very decidedly the case in the district to the east (Sheet 46), the sands and limestones being there found indifferently on all horizons throughout the formation.

The main mass of this formation takes up a space of a few square miles at the south-eastern corner of the district, its boundary running nearly parallel to the course of the Thame, and at a distance of from a quarter to half a mile from the river, to the gradual wearing action of which we may conclude that the escarpment of the Portland Beds and the separation of the outliers of Long Crendon and the Winchendons are owing. The top of the escarpment is formed by the limestone, capped in parts by higher formations, and the lower sandy division

* It was in 1857 that I mapped some of the Portland and Lower Greensand outliers in this country. I had then very little geological experience, which must be the excuse for these not very detailed notes. My colleague Mr. Hull, and my former colleagues Mr. Bauerman and Mr. Polwhele, have left but few notes of the parts which they mapped; I have therefore largely used the old and well-known paper of Dr. Fitton, who must have examined this district very carefully.—W. Whitaker.

crops out a little way down the slope. There are stone-pits here and there.

Outliers.

The two most marked features in the south-eastern part of the district, Muswell and Brill Hills, are owing to outlying patches of this formation capped by Lower Greensand, with perhaps a very thin layer of the Purbeck Beds between. These outliers are well marked, both by the rise of the ground where the higher beds come on, and by the many springs that flow from them, the water being thrown out by the Kimeridge Clay below.

Muswell Hill.—Dr. Fitton says that "the Portland Stone appears to "be wanting here," but that there is "Portland Sand with green par-"ticles,"* and fossils. I have however seen a section of limestone beneath the many coloured clays and sands of the Lower Greensand in a field by the road up the hill from Blackthorn, and at other places.

Brill.—There are many sections of the Portland Beds in this outlier. Dr. Fitton has published an account of three,† the first of which may perhaps have been at the same place as the following, a little way out of the village on the road to Muswell Hill, and between the road and the windmill :—

	ft.
Lower Greensand. - - - about	10
Portland Stone, with a thin shaly layer (Purbeck?) at top, and a two or three inch layer of dark slate-coloured clay two feet lower down. - - - -	12
Portland Sand, of which there is shown about. -	4
By the roadside lower down there is Kimeridge Clay.	

Dr. Fitton's sections seem to give a greater thickness than the above to the Portland Stone. The following details are taken from his paper (p. 280).

		ft.	in.
Lower Greensand.	Grey sand. - - - - - -	5	0
	Clay with yellow ochre in the lower part. -	4	6
	Yellow ochre, dull, some fuller's earth in the lower part. - - - -	4	0
	Thinly bedded, greenish-grey fuller's earth; the lowest part sometimes with thin seams of coaly matter; fragments of shells. Thin bedded alternations of dark-grey and light-coloured sandy clay.	1	6
	Greenish matter, often bedded, coarse fuller's earth.	3	0
Portland Stone.	Whitish, rubbly stone (fossils). - 1 ft. 3 in. to	1	6
	Hard compact grit; sand concreted by a very large proportion of calcareous matter. - - Yellowish-green fuller's earth. - - Compact grit, more sandy than that above. -	2	0
	Grey clay. - - - - -	0	6
	Limestone, in two beds. - - - about	2	6
	White limestone (fossils). - - - -	4	0
	Brownish clay, full of fragments of oyster shells. Good stone for building. "Greys." - -	1	0
	Alternations of indifferent stone and yellowish-grey sand (fossils). - - about	9	0
Portland Sand with green grains (fossils).			

If the "alternations of stone and sand" be classed with the Portland Sand instead of with the Portland Stone, the thickness of the latter

* Trans. Geol. Soc. 2d series, vol. iv. p. 283.

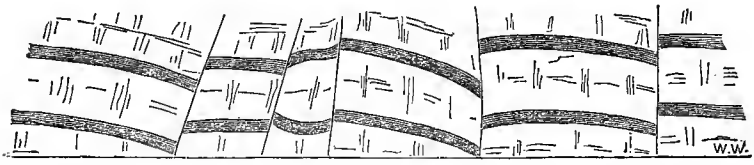
† Ibid. p. 280, 281.

will agree with that given above. Limestone bands do occur in the Portland Sand, and it is therefore often difficult to draw an exact line between these divisions of the Portland Beds; in fact it is sometimes doubtful whether the division holds everywhere.

In a small pit about two-thirds of a mile S.W. of the church I saw a number of step-faults in the limestone; they were shown by two shaly layers, and none had a greater throw than two feet.

Fig. 11.

Diagram Section of small Faults in the Portland Stone, Brill.



There seems to be a very small patch of Portland Sand at Rids Hill, about a mile N.E. of Brill.

Chilton and Long Crendon.—This is an outlier of Portland Stone and Sand, with a patch of Lower Greensand and another of Gault.

Dr. Fitton has given a section near Long Crendon, of which the following is an abstract:—

		ft.	in.
Loamy clay.	(drift or soil?) - - - - -	2	0
Lower Greensand.	Ochre, ferruginous matter and clay. - -	1	6
Purbeck Beds (?)	Rubble, slaty limestone, and clay: no thickness given.		
Portland Stone with fossils - - -	about	8	0
Portland Sand.	Sand, rubbly grey stone, &c. - -	18	0
	Greenish-grey sand - - - about	30	0
Kimeridge Clay beneath.			

About a mile south of Long Crendon there is a small outlier of Portland Sand.

Chearsley and Nether Winchendon.—The range of hill north of these villages is formed by a mass of the Portland Beds, with two small patches of Lower Greensand. Limestone is shown along the higher parts (that of Winchendon Hill seems to be separate from the larger mass on the west), sand with stone lower down, and then Kimeridge Clay. The road-cutting down the hill, rather more than half a mile to the west of Nether Winchendon church, shows Portland Sand, the lower part bluish and somewhat tenacious, and passing gradually into the Kimeridge Clay beneath.

Over Winchendon.—This outlier is barely separated from the last, being indeed on the same range; and here also stone is shown along the hill top, and sand with stone on the flank.

A mile or more S.E. of Over Winchendon there seems to be a small patch of Portland Sand, part of which lies in the district to the east (Sheet 46 S.W).

Ashendon.—A quarry on this outlier near the village showed the following beds:—*

	ft.	in.
Stone. - - - - -	10	0
Sand. - - -	4	6
Stone. - - - - -	4	0
Rubbly bed. - - - -	4	0

* From Mr. Bauerman's Note-book.

Lodge Hill.—Forming the high ground to the S.W. of Waddesdon is another well-marked outlier of the Portland Beds with two small patches of Lower Greensand, which however calls for no particular remark.

Quainton.—My former colleague, Mr. Polwhele, has left no notes of the Portland outlier, which with its capping of Lower Greensand forms the well-marked Quainton Hill; and I therefore take the following details of the Portland Beds "in the eastern pits, near the Ordnance "Station," from the oft-quoted paper of Dr. Fitton (p. 290);

	ft.	in.		ft.	in.
"Builder's" limestone (fossils).	2	6	to	3	0
Limestone, full of fossils.	5	6	to	6	0
Sand, about	6	0			
"Middle Rock" and rubble; stone abounding in fossils.	5	0			
Sand.	2	0			
Greenish concretionary stone, rough and sandy.	1	6	to	2	0
"Bottom Rock," greenish gritty limestone with stems of *Siphonia*; pits not dug lower.					

"The Portland Stone in this part of the country becomes much more sandy at the lower part, and seems to pass into the sand beneath."

FOSSILS from the PORTLAND SAND and STONE.—Named in Dr. Fitton's Memoir, Geol. Trans. 2d ser. vol. iv. p. 299. Those marked with an asterisk are added from the Collection of the Geological Survey, on the authority of Mr. Etheridge.

FOSSILS.	Brill.	Quainton.	Long Crendon.
MOLLUSCA.			
LAMELLIBRANCHIATA.			
Exogyra spiralis, Goldf. st.	×		
* *Lima rustica*, Sow.		×	
Ostrea expansa, Sow.	×		
Pecten lamellosus, Sow.	×		
* *Pecten*		×	
Perna quadrata, Sow.	×	×	×
Astarte cuneata, Sow. st.		×	
Cardium dissimile, Sow.	×	×	
* *Lucina Portlandica*, Sow.	×		
* *Modiola pallida*, Sow.	×		
Myacites gibbosa, Sow. st.	×		
Mytilus, s.	×		
* *Mytilus*		×	
* *Panopæa*		×	
Thracia depressa, Sow. st.	×		
Trigonia clavellata, Park. s.	×		×
T. elongata, Sow.	×		×
T. gibbosa, Sow.	×		
T. incurva, Sow.	×	×	
GASTEROPODA.			
Buccinum naticoides, Sow. s.	×		
* *Natica elegans*, Sow.		×	
Pleurotomaria rugata, Benett. st.	×		
CEPHALOPODA.			
Ammonites biplex, Sow. s.		×	
A. giganteus, Sow. s.	×		

Where no letter is placed after the species it is found both in the sand and stone: s. sand, st. stone. This applies, however, only to the fossils given on the authority of Dr. Fitton.

Purbeck Beds.

The change from the thick-bedded uniform limestones of the Portland Series, to the Purbeck group of thin-bedded limestones and clays, no two of which are alike, and where in the space of a few feet we have as many changes in the mineral character of the beds as can be well counted, is very striking, and even in the absence of fossils would serve to distinguish the two formations.

These beds however are but little seen in the present country; from Cuddington eastwards there is a patch of Purbeck covered in part by Lower Greensand, and half-a-mile westward of Haddenham church is a small outlier also partly hidden by Lower Greensand. In the adjoining map (46 S.W.) are many good sections in this formation, which will be described in a Memoir on that country.

Quainton.—Of some beds on this outlier whose age is very doubtful Dr. Fitton says, "The tough clays near the junction of the incumbent "strata with the Portland Beds are well seen . . . in the heights "about . . . Quainton. It is difficult or impossible in some cases to "determine whether they are to be referred to the Fullers Earth of "the Lower Greensand, to . . . the Weald Clay and Hastings Sand, "or to the Purbeck Series." Further on he gives the following section of these beds and the Lower Greensand at Quainton, "about a furlong "east of the Ordnance Station."*

	ft.	in.
Red sand with concretions of hard ferruginous conglomerate; ochre at the bottom.	2	0
Alternations of clay and sand, brownish and grey. - 1 6 Fullers earth, wax-like, as at Brill, (see p. 47) - 0 9	2	3
White and brown sand and clay.	0	9
Alternations of white, reddish, and yellowish sands with thin layers of grey clay. - 4 0 to	6	0
Dark brown clay, "Black Dirt." Alternations of tough grey clay and sand.	1	0
Greenish sand, said to be	6	0
The beds next below obscure, but said to be—		
"Black Dirt," tough grey clay.	0	3
"Grey Dirt," grey sandy clay with fragments of shells.	6	0 (?)
"Hard Stone," sandy grit and sandstone with *Paludina* and *Cyclas* (?): has been found in masses 5 feet thick and 15½ feet long."	3	0

The following still lower beds were shown "in another part of the "hill, under red sand and hard ferruginous conglomerate (carstone)," perhaps Lower Greensand, and are classed as Purbeck by Dr. Fitton.

	ft.	in.
"Heath," white sand and clay, full of decomposed shells in layers.	3	0
"Pendle," fissile oolitic stone, with *Cypris*, &c.	0	6

As the age of these beds is doubtful, and as they cannot be traced with certainty, they have been placed on the map with the Lower Greensand; Dr. Fitton gives the following fossils from them :—

Cyclas, impressions of. Quainton, "pit at the highest part of the hill, in grey calciferous grit, 'Hardstone.'"
Paludina elongata, (?) Sow. Impressions.
Serpula (?) Coney Hill. "In grey uniform grit."
Cyclas parva. Quainton. "Western pit in the 'Pendle.'"
——— a large species. Haddenham. "In slaty limestone."

* Trans. Geol. Soc. 2d series, vol. iv. pp. 286, 290.

Cypris (*Cypridea*), *Valdensis?* Sow. Quainton.
———, species uncertain. Quainton.
Modiola. Quainton. "A small species in tough sandy clay in the bottom of the 'Heath,' over the 'Pendle.'"
Mytilus. Quainton.
Paludina. Do. "In the grey uniform grit."
Unio. Do.
Fish vertebræ. Coney Hill. "In calciferous grit."
—— scales. Quainton. "Pit at top of the hill, in the 'Hardstone.'"

CHAPTER VI.

CRETACEOUS BEDS.

Lower Greensand.

In this district the Lower Greensand consists of sands, for the most part ferruginous, with iron-sandstone and ironstone; many coloured clays and fullers earth; and sometimes beds of ochre. It is present only in the form of outliers.

Forest Hill.—A small patch of this formation is here brought against the Coral Rag by a fault with a downthrow of about 30 feet.*

Near Haddenham are four small outliers of this formation, two on the west and two on the east of the village, and to the north-east is a larger mass which runs into the country on the east (Sheet 46 S.W.), and is capped by Gault.

A small patch of Greensand caps the Purbeck Beds just west of Cuddington.

Muswell Hill.—The capping of Lower Greensand on this hill consists of sand, for the most part red, some yellow, with ironsandstone (sometimes in large masses); and clay, dark and pale blue, whitish and orange-coloured. It is shown along the roads over the hill.

Brill.—Just outside the village, on the road to Muswell Hill, there are pits in this formation. One of them showed (1859) alternations of pale and dark blue clays, in part shaly and in part sandy, with sands and thin layers of ochre; some of the dark shale looks like Oxford Clay, and some of the blue clay like Gault. In another pit I saw nothing but blue clay; and in a third there was in the upper part brown, yellow, and grey sand with thin layers of clay; below this sand, partly laminated; then six or eight inches of a very bright green clay, with a thin ochreous layer at top; then a thin layer of ironstone; and then pale yellow clay. These pits are worked for bricks and tiles, and I believe that pottery also is made from the stiff clays.

The first of Dr. Fitton's sections at Brill may have been at the same place as the above. His details are:—†

		ft.	in.
Lower Greensand.	Grey and yellow sand.	6	0
	Alternate layers of ferruginous sand and clay.	15	0
	Black, grey, whitish, and ferruginous sand, with flakes of yellow ochre.	0	2
	Layer of wax-like clay (fuller's earth), green, yellow, and reddish.	0	6
	Sand, increasing in firmness lower down.	4	0
Portland Stone.			

* See Geol. Survey Memoir, on Sheet 13, p. 8.
† Trans. Geol. Soc. 2d series, vol. iv. p. 280.

Another section, south-west of the village, showed the following beds of this formation :—

	ft.	in.	ft.	in.
Sand, white at top, yellow and ferruginous below. -	6	0 to	7	0
Gravel (?) with concretions of "carstone" (iron-sandstone). - - -	1	6		
Yellow ochre, of good quality, used in commerce. -	1	8 to	1	10
Clay, with thin bands of ochre. - - -	1	0		
Light bluish-grey clay, no more shown than -	5	0		

"About six feet down (in the last bed) an entire tree was found, "converted into lignite much mixed with pyrites. The trunk, about a "foot in diameter and full 40 feet long, lay almost horizontally . . . "and branches extended to about 10 feet beyond it on both sides . . . "Beneath the tree, it had been ascertained by boring, that clay, of "colour, extended to about 12 feet in depth."

Another pit, near by, gave the section on p. 47.

The first of these sections of Dr. Fitton's shows a thickness of 25 feet of Lower Greensand. The total thickness however must be more than this, as the pits are not at the highest part of the hill.

Sand is also shown along the roads.

Quainton Hill is capped by Lower Greensand, for the details of which see page 50.

There is a patch of the sand of this formation cappiug the Portland outlier of Chearsley, on the hill north-west of that village, where sand is shown along the roads ; and there seems to be a smaller and thinner outlier a little to the north-east, above Pigotts.

W. Whitaker.

Gault.

This is a thick mass of pale blue clay, sometimes shaly, often with whitey-brown phosphatic nodules. The more detailed description must be put off till we have to take in hand the main mass of the formation, about half a square mile of which lies in the south-east corner of the present country, at Aston Sandford, but of which a much larger spread is found in the adjoining district (map 46).

There are also outliers, (1) on the hill north of Long Crendon, (2) north-east of Haddenham, and (3) along the line of the high road from the south of Cuddington, running eastwards into the adjoining map (46 S.W.) The northern boundary of the latter runs parallel to the high road, and a few chains to the north of it, while on the south the clay takes up a greater space and is shown at the kiln.

We see in the present country instances of the manner in which the Gault overlaps the Lower Greensand, the former at times resting on the Portland Stone without any trace of the latter or the Purbeck between. All this, however, is far better shown between Aylesbury and Leighton Buzzard, and will be described at length in a memoir on that district.

CHAPTER VII.

POST-PLIOCENE OR DRIFT, VALLEY GRAVELS, AND ALLUVIUM.

Under this head we have in the present district, the clays and gravels of the Boulder or Glacial period, the Low level or Valley Gravels of later date, and the more modern Alluvium.

The first, as the reader will already have gathered and as the geological surveyor soon finds to his cost, are widely spread over a great part of the country. The north-western quarter of the sheet is singularly free from drift, but a little patch of gravel lies on the top of the hill above the Banbury workhouse. In the Woodstock district we learn from Mr. Hull "that all the higher ground and most promi-"nent elevations are capped by gravel consisting principally of rounded "quartz pebbles, but in which there also occur flint, hornstone, and trap. "This gravel is accompanied by beds of yellow sand and bluish clay, "the former generally presenting evidence of current action from the "north. We find these beds on Wytham Hill, at a height of upwards "of 500 feet, on Round Castle Hill, south of Bladon, on Leafield "Barrow, Ramsden Heath, and the high ground formed of Oxford "Clay at Kirklington and Bletchingdon. There is therefore no "doubt that it once formed a continuous covering extending to all "these points, and that it has subsequently been removed by denu-"dation from those parts of the district which are below a certain "level."*

It is, however, in the north-eastern part of the district that the Boulder Beds show in greatest force; to the east of a line through Gretworth, Brackley, Mixbury, and Hardwick the whole of the country with the exception of the deeper valleys is thickly covered with them.

Three very distinct forms occur:

1. Clean gravels, without any admixture of clay.
2. Stiff blue clay, with few pebbles, and here and there large, angular, ice-scratched boulders.
3. Clayey and dirty gravels.

A very large proportion of the pebbles in the clean gravels are of Oolitic rocks, chalk flints come next in number, and we occasionally meet with quartz pebbles, blocks of slate and igneous rocks, and small pieces of gneiss and granite.

These beds are found most plentifully about Hardwick; along a band, about half a mile broad, running from Finmere to Buckingham; and round Maids Morton, Stowe, and Akeley.

The pebbles are far the most part well rounded and not very large, with a few larger, half-angular blocks, and there is well-marked though very irregular bedding; the sketch below of a gravel pit at Tingewick will give an idea of the general look of these beds.

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* Geology of the Country round Woodstock (Mems. of Geol. Survey), p. 27.

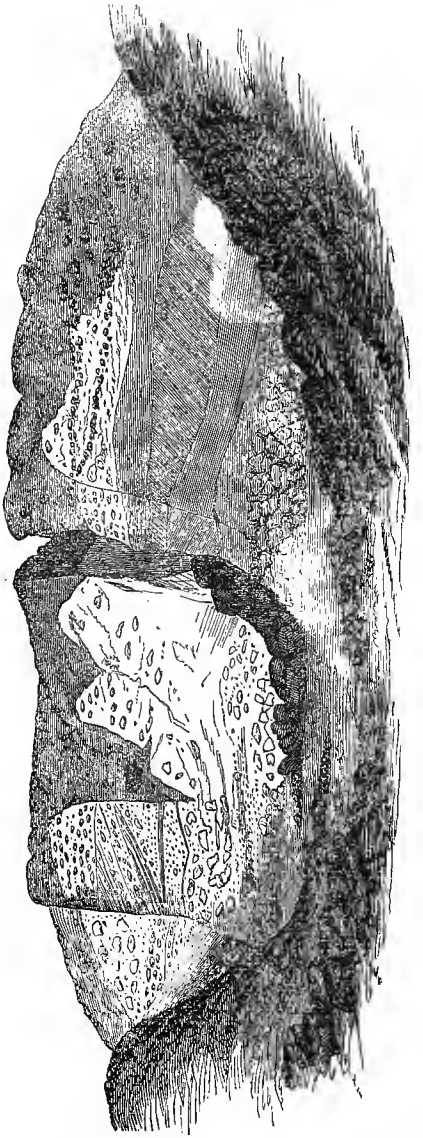


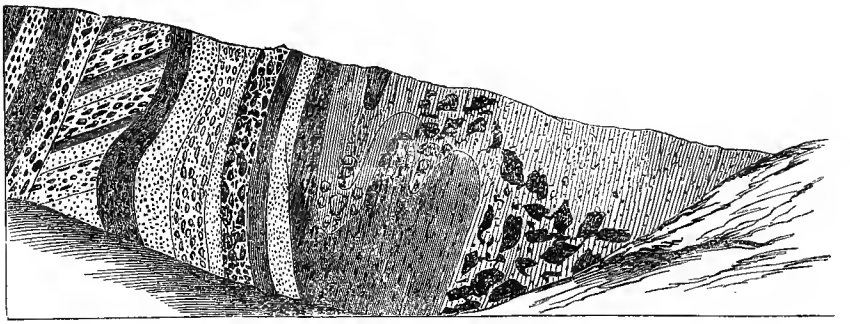
Fig. 12.—Gravel Pit at Tingewick.

The beds on the left are gravels of different degrees of coarseness and very much false bedded : on the right are beds of soft, clean sand, crossed by a small fault, with gravels above and below.

A very fine section was also laid open behind the Buckingham workhouse, which showed about 40 feet of fine gravels and sand very irregularly stratified ; and this is the form which these gravels mostly take. We do, however, sometimes find confused masses of very coarse gravel, made up of large, half-angular blocks, tossed together without any

approach to order, looking very much like the heaps of debris that lie at the foot of rocky cliffs on the sea-shore. Such a gravel may be seen just outside Buckingham on the road to Stony Stratford, not a quarter of a mile from the fine bedded gravel, just mentioned, behind the workhouse. About Foxcott and Maids Morton these gravels are largely worked, and we have there good instances of contorted bedding, which is not uncommon in these deposits.* A sketch is given below of a gravel pit near Foxcott where the beds are all but vertical, and another still more remarkable case of folded beds at Tile House Farm near Buckingham.

Fig. 13.—*Section in rudely Stratified and Contorted Gravel, Foxcott.*



* See Mr. Trimmer in the Quarterly Journal of Geological Society, vol. vii. p. 22, 30; Sir C. Lyell, "On the Antiquity of Man," p. 222.

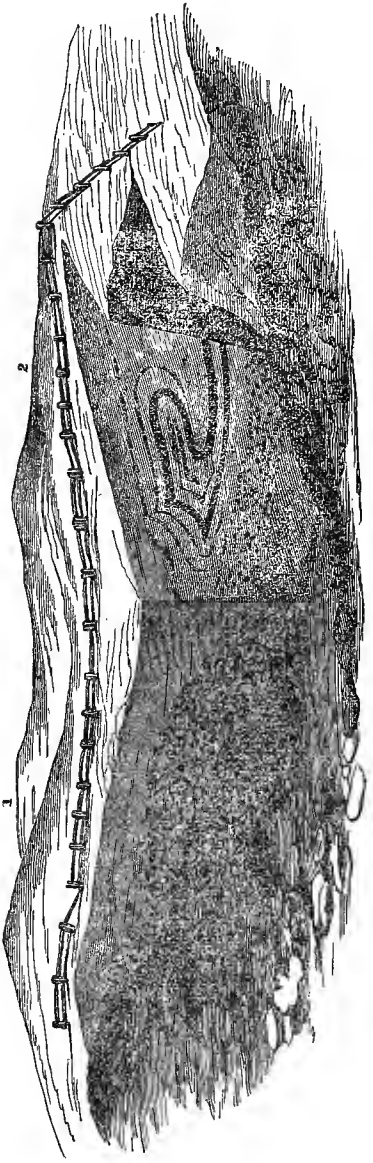
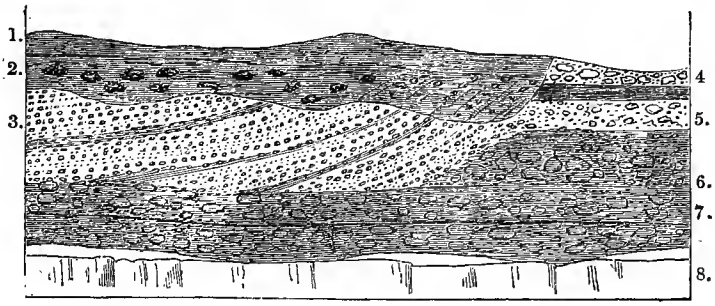


Fig. 14.—*Gravel Pit.*—*Tile House Farm, Buckingham.*

1. Gravel and sand.
2. Red clayey sand, and contorted layers of dark clay, resting on sand.

We give one more section which shows well the very irregular bedding of these deposits.

Fig. 15.—*Section of a Gravel Pit, two miles from Buckingham on the Bicester Road.*



1. Surface soil.
2. Drift clay with angular lumps of blue clay.
3. Very fine irregularly bedded gravel.
4. Coarse gravel and sand.
5. Sand and gravel.
6. Very coarse gravel.
7. Coarse dirty gravel in two beds.
8. Hard white limestone, with traces of white clay above. Great Oolite.

Height of section 18 feet.

These gravels also occur of great thickness about Silverston and Whittlebury.

Another very marked form of these drift beds is the stiff blue clay with few pebbles, which seems to occur here and there in patches of small extent. At the time the survey was made it was best shown in some deep drain cuttings on the hillside below Leckhampstead Farm; it was there very stiff and contained boulders in no very great number; there were a few blocks of Lias and Oolitic limestone, some of quartz rock and coal-measure sandstone, and many angular or half-rounded masses of carboniferous limestone, the largest of which, an angular slab, measured 1 ft. 6 in. × 1 ft. × 2 in. The boulders of carboniferous limestone were all thickly covered with clear ice-scratches; a few faint scratches were seen on the sandstone, but none on the Oolitic rocks.

An irregular bed of this clay was seen underlying clean gravel at Silverstone; the two are occasionally found interstratified with each other.

This clay is also worked for brick-making at Lovell Wood, south of Whittlebury, where we have the section below:

Sandy gravel from one to two feet.
Dark blue clay with a few pebbles at the top and angular bits of quartz rock, or altered Carboniferous sandstone, in the lower part.

A large rounded boulder of white vein quartz and Lias and Oolitic fossils were found in the clay.

Boulder clay overlaid by coarse angular gravel may also be seen in the two railway cuttings immediately to the S.E. of Buckingham station. I noticed in the clay pebbles of chalk and chalk-rock, flints, blocks of Oolitic limestone, and one large ice-scratched boulder of carboniferous limestone. The gravel here and elsewhere is at times cemented into a conglomerate by oxide of iron.

The third and commonest form under which the drift shows itself is that of a clayey, dirty gravel, which forms a sort of link between the stiff clays and the clean gravels just described. We find the drift taking this shape upon the clay country, (Oxford or Kimeridge, as the case may be); to the north of Stowe; about Radston and Biddlesden,

and on the high ground of Whittlewood Forest. Quartz pebbles and flints are plentiful in these clayey gravels, and pebbles of the local rocks comparatively scarce.

When the drift of central England has been more largely looked into, it may be possible to form some notion what relation these three forms bear to one another and to the corresponding deposits in the north. At present little can be said on the matter, though it is not unlikely that the clean gravels, the clays with few pebbles, and the clayey gravels, are only different shapes of the same deposit, brought about by a difference in the local conditions under which it was laid down. Or the following theory may be hazarded. The pebbles in the Boulder Clay are mostly foreigners and it is often found underlying gravel, though this is by no means always the case. It may therefore be the oldest of the drift deposits and may formerly have been of wider range than at present. The gravels may have been formed afterwards, and while the bulk of them came from the Oolitic rocks of the neighbourhood, the denudation of the Boulder Clay may have furnished the quartz pebbles and flints and the clay beds found here and there lying among the gravels. The fact that a gravel is clean or dirty may depend partly on the nature of the sea-bottom on which it was laid down, and partly on the amount of the older Boulder Clay that was mixed up with it.

Low-level or Valley Gravel.—"These gravels are composed principally of the detritus of the surrounding oolitic strata, and occupy positions not exceeding 300 feet or thereabouts above the sea level. Elephant remains (probably those of *Elephas primigenius*) are found very abundantly in this gravel.

"At Ascott, in the valley of the Evenlode, in excavating the gravel for the railway the skeleton of a fossil elephant was discovered. Here the relative position of the older and newer gravels may be well observed, and has been already illustrated.* The difference of level between the quartzose gravel at Leafield Barrow and the elephant gravel of the valley of the Evenlode at Ascott is about 250 feet. In the valley of the Windrush we meet this gravel again between Ducklington and Witney. At Hanborough we find it resting on the Cornbrash at an unusually high elevation. At Yarnton and Woodstock Road station good sections have been opened up in the gravel of this period, occupying elevations of about 240 feet above the sea. These beds are composed principally of Liassic and Oolitic pebbles, generally small and rounded. Waterworn oolitic fossils, as *Gryphæa*, *Terebratulæ*, *Belemnites*, are also to be found, but no shells belonging to the period at which the gravel was formed; the only representative of that epoch being fragments of elephant's tusks. Besides fragments of local rocks, there are pebbles derived from the more ancient drift, such as quartz, flint, and hornstone, which have become re-embedded.

"In the cutting of the railway near Combe there is an interesting section, where we see the beds of the Great Oolite worn into a channel which has afterwards been filled in by gravel of this period."†

"Just out of Oxford, on the Bicester road, a pit was open in 1857 in rather fine, light-brown, sandy gravel, made up of fragments of iron-sandstone, flint, and pebbles of quartz-rock. The like was seen further on the same road, just beyond Summerstown; and further still by the turnpike, and by the river at Summerstown."‡

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* Geology of Cheltenham.

† Geology of Country round Woodstock, p. 27.

‡ From the Note-book of Mr. W. Whitaker.

"A pit below Yarnton, on the Oxford, Worcester, and Wolverhampton Railway, showed 20 feet of fine sandy gravel, made up of quartz, oolite, lower greensand, and chalk flints."* Prof. Phillips mentions that the bones of boar, goat, ox, horse, and elephant have been found in the Yarnton Gravel.†

With the exception of the alluvium, and in some cases of the valley gravels, the boundaries of the Post-Pliocene deposits have not been hitherto laid down on the maps of the Geological Survey, and indeed it would be impossible on the one-inch scale to show on the same map these beds and the stratified rocks. Additional surface maps, however, are now in course of preparation, on which the areas covered by superficial deposits will be marked out, while over the parts of the country free from drift the boundaries of the stratified rocks will be laid down, and the probable continuations of these latter beneath the drift covering shown by faint dotted lines.

Sarsen Stones: Greywethers.—"These are large blocks of hard grit which lie scattered at intervals over the district, but which cannot be referred to any of the surrounding formations. They may be seen along the northern flanks of Wychwood Forest, and in the valley of the Evenlode near Ascott. These blocks increase in number and size towards the chalk downs of Wiltshire, and have been shown by Mr. Prestwich to be the relics of an Eocene sandstone which from its extreme hardness has resisted the destructive agency of the sea during the denudation of the underlying formations. As this subject has been treated of by Professor Ramsay in the memoir on sheet 34 it will be unnecessary to enter into the subject more fully."‡

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* From the Note-book of Mr. Bauerman.

† Oxford Essays for 1855, p. 197.

‡ Geology of the Country round Woodstock, p. 28. See also Memoirs on Sheet 13, p. 47; on Sheet 12, p. 51; on Sheet 7, p. 71; and a paper by Mr. Whitaker in the Quarterly Journal of Geological Society, vol xviii. p. 271.

INDEX OF PLACES.

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LIST OF GEOLOGICAL MAPS AND SECTIONS OF THE GEOLOGICAL SURVEY OF THE UNITED KINGDOM,

PUBLISHED BY MESSRS. LONGMAN & CO. FOR HER MAJESTY'S STATIONERY OFFICE.

THE Maps are those of the Ordnance Survey, geologically coloured by the Geological Survey of Great Britain and Ireland, under the Superintendence of Sir RODERICK IMPEY MURCHISON, K.C.B., F.R.S., Director-General. The various Formations are traced and coloured in all their Subdivisions.

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42 SW. SW. of Brecknock, part of North Glamorgan.
42 SE. NE. of Glamorgan and Monmouth Coalfield.
43 NW. Hereford.
43 NE. Great Malvern.
43 SW. The West of Dean Forest Coalfield.
43 SE. The greater part of Dean Forest Coalfield.
*44 Cheltenham, East Gloucestershire. 6s.
*45 SW. Part of Oxfordshire (Woodstock).
45 NW. Banbury.
45 NE. Buckingham and Brackley.
45 SE. Bicester.
46 NW. Newport Pagnell, and Woburn
52 SW. Northampton and Olney.
*53 NW. Part of Warwickshire—Coventry.
53 SW. Southam. Part of Warwickshire.
*53 SE. Northampton.
*53 NE. Part of Northamptonshire and Warwickshire.
54 SW. Part of Worcestershire.
*54 NE. Part of Warwickshire.
*54 NW. Part of Worcestershire.
54 SE. Part of Warwickshire.
*55 NE. Part of Shropshire and Worcestershire.
55 NW. Part of Hereford, Worcester, and Shropshire.
55 SW. Part of Hereford.
*55 SE. Part of Hereford and Worcester.
56 NW. Part of Brecon, Cardigan, Radnor, and Montgomery.
56 NE. Part of Radnor, Montgomery and Shropshire.
56 SW. Part of Radnor, Brecon, and Carmarthen.
56 SE. Part of Radnor and Hereford.
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60 SE. Part of Montgomery, Radnor, and Shropshire.
61 NW. Part of Shropshire.
61 NE. Part of Shropshire and Staffordshire.
61 SW. Part of Shropshire.
61 SE. Part of Shropshire.
*62 NE. Lichfield, part of Staffordshire.
*62 SE. Birmingham, part of Warwickshire.
*62 SW. Part of Staffordshire, including the Coalfield.
*62 NW. Part of Staffordshire, including the Coalfield.
*63 NW. Ashby-de-la-Zouch, part of Leicestershire.
63 NE. Leicester.
*63 SW. Hinckley, part of Leicestershire and Warwickshire.
*63 SE. Part of Leicester, Warwick, and Northamptonshire.
*71 NE. Nottingham.
71 NW. Nottingham, part of Derbyshire.
*71 SW. Derby.
71 SE. Part of Nottinghamshire.
72 NW. Hanley. Part of Staffordshire.
72 NE. Part of North Staffordshire and of SW. Derbyshire.
72 SW. Central Part of Staffordshire.
*72 SE. Part of Staffordshire and SW. Derbyshire.
*73 NW. Part of Cheshire.
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74 NW. Part of Denbigh, Merioneth, and Caernarvon.
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74 SW. Part of Montgomery, Denbigh, and Merioneth.
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75 NW. Part of Caernarvon.
75 NE. Part of Caernarvon, Merioneth, and Denbigh.
75 SW. Part of Caernarvon.
75 SE. Part of Merioneth.
76 N. Part of Caernarvon.
76 S. Part of Caernarvon.
77 N. Part of Holyhead Island.
78 NW. N. part of Anglesea, and part of Holyhead Island.
78 NE. E. corner of Anglesea.
78 SW. S. of Holyhead Island and of Anglesea.
78 SE. Part of Anglesea on Menai Straits.
79 NW. Part of Flint, Denbigh, and Caernarvon.
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